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ART. XLVI.—*On the Solar Corona;* by Prof. C. A. YOUNG, of Dartmouth College.

ALTHOUGH we have not yet official reports from the different parties who observed the solar eclipse of last December, it is perhaps not necessary to wait for them in order to form an idea of the state in which the problem of the sun's corona now stands.

From what has already appeared in the scientific and news journals, it is clear that while little new matter has been added to the stock of scientific knowledge, and while some questions are left in a more puzzling condition than ever, yet certain of the conclusions arrived at in 1869, but received with a good deal of reserve in certain quarters, have been fully confirmed and placed beyond further reasonable doubt.

The polariscopic observations are less accordant and conclusive than might be wished; undoubtedly because at all the stations they were more or less interfered with and complicated by the presence of clouds or haze.

On the whole, however, they seem to show pretty definitely that a portion of the coronal light is polarized in radial planes, and is therefore derived, not self-originated—almost certainly simple reflected sunlight—though, of course, the polariscope does not inform us whether the reflecting particles are near the sun, or the moon, or in our own atmosphere.

Very perplexing also is the fact that the faint continuous spectrum, which must be in part produced by this polarized component of the corona's light, shows no discoverable traces of the dark lines of the ordinary sunlight-spectrum. Probably

they exist but are in some way masked so that they are not easily detected.

But if we grant that the polariscope has demonstrated the derivative character of one fraction of the coronal radiance, it is far more certain that the spectroscope has proved some of the matter of the corona, if not all, to be self-luminous; for its spectrum is characterized by a *bright line.* This line both in 1869 and 1870 was identified with a bright line of the chromosphere-spectrum which coincides exactly with a dark Fraunhofer line at 1474 of Kirchhoff's scale—(wave length 5316 according to Angström). Perhaps I may be allowed to step a little out of my way to add, that while it is customary to speak of this line simply as "a bright line near E," as if its exact position were somewhat doubtful, there is no occasion for the slightest reserve in the matter. The coincidence of the bright C line of the protuberance-spectrum with the dark C is no more accurately ascertained.

In the eclipse of last December, just before the beginning of the totality, the cross wires of my spectroscope were set carefully upon this line, already plainly bright in the spectrum of the chromosphere; and as soon as the sun was covered, I traced it out into the corona more than 16′ from the sun's limb. With the full dispersive power of 13 prisms, I have never been able to find the least want of correspondence between this line as seen in the chromosphere and its dark analogue, except occasionally such as was evidently due to the motion of the luminous matter, producing slight changes of refrangibility, sometimes in one direction and sometimes in the other.

So far as I can learn, this line was verified last December by all the spectroscopic observers who saw anything at all, with the single exception of Lieut. Brown of Lord Lindsay's party.

Two other faint lines which I saw in 1869 between this and D, and doubtfully* reported as corona-lines (see this Journal for Nov. 1869, p. 376), were not seen by any one on this occasion, unless perhaps one of them by Father Denza in Sicily.

In a letter from Father Secchi which appeared in the Astronomische Nachrichten for Feb. 21, 1871, he writes, "*Mon collegue le P. P. Denza directeur de l'observatoire de Moncalieri, observa avec un spectroscope, que j'avais convenablement disposé,* deux *raies brillantes dans le couronne, une près de l'E de* Fraunhofer, *l'autre au milieu entre le vert et le jaune.*" Very possibly this latter ray "half way between the yellow and the green" may be one of the two.

Considered as a demonstration of self-luminosity, however, *one* bright line is just as conclusive as many.

* I have experienced some annoyance during the past year at seeing these lines in several publications put upon the same footing as 1474. I was never at all confident as to their coronal character.

Nor can there be any doubt as to the location of the self-luminous matter. It cannot be in our own atmosphere, for no possible reason can be assigned why the particular molecules of air, that happen to lie near the lines which join the eye of the observer with the edge of the moon, should become luminous rather than others in a different portion of the sky.

Nor can it be at the moon; otherwise of course it would always be visible around her disc, since there is nothing in the mere accident of her being on the line of syzygies which could account for the phenomenon. I may add in passing, that I have often and carefully examined the neighborhood of the moon's limb, half hoping that some possible rare atmosphere of our satellite might reveal itself at some time by a faint auroral spectrum; thus far, however, without success.

Accordingly it is now universally, I think I may say, acknowledged that *one important element of the corona consists in a solar envelope of glowing gas, reaching to a considerable elevation.* Mr. Lockyer, who is still disposed to assign to the solar element of the corona a lower relative importance than most other astromomers, concedes a thickness of from *six* to *ten* minutes. (See an article by him in Nature for Feb. 23d.)

For this envelope the name of "*leucosphere*" has been proposed by a member of the Royal Astronomical Society at one of its recent meetings, and it seems to be a very suitable term and well worthy of adoption. It has been objected to on the ground that "*chromosphere*" covers the whole bright-line region around the sun; but when the latter name was first proposed, there was evidently no idea that above the envelope of hydrogen there lay another from 20 to 100 times as extensive, and it would certainly be very convenient to restrict it to the lower red hydrogen stratum of the solar atmosphere, and retain the new term to designate this more elevated mass of gaseous matter.

How extensive then is this leucosphere? Perhaps the question can hardly be answered definitely as yet; but it seems likely that it will be found to be at least from 8′ to 10′ thick on the average, with occasional prolongations of double that extent; not impossibly it may turn out to have no upper limit whatever, but to extend outward indefinitely into space.

Were it not for the interference of our atmosphere, the matter could be settled very summarily, at least as to a minor limit, by the record of the spectroscopic observations. Prof. Winlock observed the green line at a distance of more than 20′ from the sun, and others nearly as far. But there can be no doubt that had the spectroscope, during the eclipse, been directed upon any reflecting surface illuminated by the corona light, the same green line would have appeared in its spectrum. The question, of course, at once arises, whether the presence of this line at such a distance from the sun was not due to atmospheric reflection,

especially as the sky was full of haze and light cirrus clouds at all, or nearly all, the stations of observation.

It is certainly difficult to say that such might not have been the case to some extent, for the hydrogen lines were seen at an elevation of 4′ to 5′, far above any possible hydrogen, and faintly even on the disc of the moon itself—evidently by just such an atmospheric reflection.

There is, however, an important difference between the behavior of the hydrogen lines, and that of 1474. At the edge of the chromosphere there was a sudden and very great falling off in the brightness of the former, while no such boundary was observed for the latter; the line grew regularly and continuously more faint as the distance from the sun increased, until it simply faded out, no abrupt alteration of its brilliancy being anywhere noticed. (I now speak of my own observations; but so far as I have learned, the experience of others was the same.)

In 1869 the difference between the hydrogen lines and 1474 was still more marked. The former could hardly be traced at all beyond the actual limit of the chromosphere, the air being so clear that there was very little atmospheric effect.

But there is another way of approaching the subject. The spectroscopes used by our party at Jerez were of two different classes, and by a combination of their results we may obtain an indication of considerable value.

In the instruments employed by Prof. Winlock and myself, and I presume by the greater number of the eclipse observers, the spectroscope is attached to the eye-end of a telescope whose object-glass throws upon the slit a distinct image of the body to be examined. Such an instrument may be called an *analyzing* spectroscope, since it deals with elementary portions of the luminous area under investigation. Thus, if the figure represent the image of the corona, chromosphere and moon formed by the object-glass of the telescope, then if the slit be placed as at S, the spectrum seen will be produced solely by light from those elements of the luminous area whose foci fall within its jaws. The spectrum will be divided longitudinally into two portions, of which the one derived from the upper portion of S will show only the lines due to the leucosphere, while the other will exhibit the chromosphere lines *plus* those of the leucosphere.

(Of course it must be remembered that while the hydrogen does not extend above the limit of the chromosphere, the coronal matter does reach down to the surface of the sun, and in the chromosphere is mingled with the hydrogen; indeed, except

during eclipses, it is only at the very base of the chromosphere that the 1474 line can be seen reversed with our present spectroscopes.)

If now we assume the chromosphere and leucosphere each to be of uniform brightness throughout (a supposition not strictly true but allowable for our present purpose), then by putting a for the angular area of the chromosphere, x for that of the leucosphere, i for the intensity of the bright 1474 line as seen in an "analyzing" spectroscope, and ni for the intensity of the bright C line observed with the same instrument, we shall have

$$ix=[1474],$$

where [1474] represents the total quantity of "1474 light" coming from the whole leucosphere. Similarly

$n.i.a.=[C]$, where [C] represents in the same manner the total "C light" from the chromosphere.

$$\text{Hence} \quad x=n.a.\frac{[1474]}{[C]}$$

Now, as nearly as I can estimate, the ratio between the brightness of the C and 1474 lines is about the same as that between a star of the first magnitude and one of the fifth or sixth. That is to say, the C line is between twenty-five and one hundred times as bright as 1474; so that in our equations we may write $n=50$ as a fair approximation, and we shall have

$$x=50\,a\frac{[1474]}{[C]}$$

In order to find x in terms of a it only remains to find the ratio of [1474] to [C]. For this purpose we must employ a spectroscope so arranged that its slit may receive at every point, light coming indiscriminately from every part of the object. This is the case when a spectroscope is used, unconnected with any telescope, by simply pointing the slit of its collimator toward the source of light. Thus used it may be called an *integrating* instrument, since it sums up in each bright line of its spectrum, the whole quantity of each kind of light reaching the slit from the whole luminous area included within its field.

An instrument of this sort was employed by Prof. Pickering in 1869, and with results of considerable importance.

Accordingly, two of the gentlemen of our party were equipped in the same manner, and one of them, Mr. Pye, by my request, noted the brightness of the lines on an arbitrary scale from ten down, with the following result: [C] 8·5, [D^3] 5·5, [1474] 10, and [F] 3. Probably the squares of these numbers would more nearly express the true ratio of the intensities, since we seem instinctively to estimate one light as twice the intensity of another when it appears of the same brightness at a double distance, and so on.

If so, we have $\frac{[1474]}{[C]} = \left(\frac{10}{8{\cdot}5}\right)^2 = \frac{100}{72}$ nearly; and recurring to our last written equation we get $x = 69{\cdot}4\,a$.

Similarly, from D_3, ($n=20$), I find $x = 64{\cdot}5a$; and from F, ($n=10$) $x = 111{\cdot}1a$.

The last value is evidently too large, the discrepancy probably arising from the fact that Mr. Pye's instrument having a prism of the extra dense and very yellow flint-glass considerably reduced the intensity of the F line by absorption.

Thus far, we have neglected the inequalities of shading and illumination; but as both chromosphere and leucosphere decrease in brilliancy pretty regularly from the limb of the sun, and since the upper limit of the former is much the more definite, it is evident that the introduction of these considerations would increase the computed ratio. We may, I think, then safely assume that the angular area of the leucosphere is *at least* 70 times as great as the area of that portion of the chromosphere and prominences which was exposed to view during the totality. I fear it is not possible to estimate this area with much certainty, but think it could hardly have been equivalent to anything less than a ring of 9″ or 10″ wide surrounding the sun. If so, we find the leucosphere to be equivalent to a ring of about 10′ in width, and considering the irregularity of its outline, some of the angular prolongations would be likely to attain twice that distance.

I am, of course, aware that the numerical data of this calculation are very uncertain, being mere estimates, not measurements; but the principle is correct, and the results are not sensibly affected by any ordinary amount of atmospheric influence, since the different colored rays would not have the *ratio* of their brilliancies much disturbed under any reasonably fair conditions.

The result agrees very well also with the photographs, drawings, and estimates of skilled observers.

As for the *long rays*, both bright and dark, which are often, and perhaps usually, seen crossing the leucosphere and reaching far beyond, the question whether they are also solar appendages appears to be very different and far more doubtful.

In the first place, I doubt if they are *always* present. At any rate, in 1869, in a most exceptionally clear atmosphere, I saw nothing of them at Burlington, Iowa, and believe (but am not absolutely certain) that none of our party did; while some observers in Kentucky saw them well, and at Sioux City they were especially conspicuous, as is evident from the remarkable, and I have no doubt, accurate picture given by Mr. Gilman in the Eclipse Report of the Naval Observatory.

In December, so far as I have heard, every one saw them. I have no hesitation in affirming that the corona as it appeared to me then was a very different phenomenon from what I saw the year before, and far more complex.*

The photographs also taken by Lord Lindsay's and the American parties in Spain, appear to differ essentially from each other, and from those taken by Mr. Brothers, in Sicily; and that in such a way as to suggest at least, that this more extensive radiance is of a far less permanent character than the leucosphere, and possibly of a different origin.

Should it turn out to be visible only where the sky is hazy, it might then be regarded as an effect of our own atmosphere produced, of course, not by the ordinary photospheric sunlight (which, as has been abundantly shown, by many writers, cannot during totality, illuminate the air near the moon's place), but by the light from the prominences and the lower regions of the leucosphere.

If, on the contrary, as seems to be the case, this radiance is often seen under unexceptionable atmospheric conditions, we appear to be shut up to one of two theories; either on the one hand that of Prof. Norton and Mr. Proctor, whose views regarding these rays are nearly identical, and represent them to be streams of matter, similar to cometary substance or auroral† beams, driven off by some solar repulsion; or on the other hand that of Oudemans, who considers them to be purely optical effects produced in cosmical dust between us and the moon, by the sunlight streaming across the uneven and ragged edge of our satellite.

With reference to the former theory, it is probably sufficient

* Mr. Lockyer, in "Nature" for Feb. 23d, quotes from a letter of mine written a year ago, to show that my opinions regarding the nature of the corona have been considerably modified since then; and this is true to some extent, though I think the present approximation of our views is owing quite as much to a change in his own ideas—as would be evident on referring to his papers of the same, and even somewhat later date. But I should *still* write "I am strongly disposed to believe that the whole phenomenon" (*i. e., the Corona as I saw it in* 1869) "is purely solar."

† Since my name has sometimes been referred to in connection with the so-called "Auroral Theory of the Corona," it is proper for me to state, that I make no claim to be its originator.

When I discovered (as I supposed), the identity of the bright line in the corona spectrum with a line in that of the aurora, and announced my belief in the substantial identity of the two phenomena, I considered myself as simply subscribing to a view already current, and bringing a new argument to its support.

So far as I know, Prof. Norton was the first to work out and publish a connected theory of the subject, basing his conclusions largely upon his discussions of Donati's comet, which were printed in this Journal some years ago. Prof. Winlock also informs me that he has held and published a very similar opinion, and so I think have more than one of the European astronomers, though I cannot now give references. My own father, more than twenty years ago, was accustomed to teach from the same chair of astronomy which I now occupy, an essentially similar doctrine. Thus the idea had long been familiar to me, and I presume more or less so to astronomers generally.

to refer to Mr. Proctor's recent work on the sun, and to a paper which Professor Norton has published in a late number of this Journal, wherein his views are fully explained. According to this view, the leucosphere and the rays are alike solar appendages, and of identical origin and material.

The theory of Oudemans is stated in a letter to "Nature," contained in the number for Nov. 10, 1870.

With good weather, it would seem possible to decide between these two hypotheses at the next eclipse.

A series of corona photographs taken as rapidly as possible on the plan pursued by Mr. Brothers (who has shown that an exposure of from 8 to 10 seconds is sufficient to produce a fine picture) would probably indicate whether the dark streaks are really related to mountains on the edge of the moon or not.

It is probable also, as Prof. Pickering has suggested, that important information may be obtained by observing them with a spectroscope of high dispersive power and widely opened slit, using the 1474 line just as the C line is used in examining the prominences.

The telescope, to which the spectroscope employed for the purpose is attached, should be of wide angular aperture, so as to give abundant light, but of very short focus, forming an image of the sun not much more than $\frac{1}{4}$ of an inch in diameter, in order that the rays may be so little magnified that their outline, if they are really of leucospheric origin and give the green monochromatic light, may be readily observed through the slit.

There remains still unsettled another interesting series of questions concerning the nature of the substance composing the leucosphere, and the relation of this envelope to the sun; whether it be a true atmosphere, or a mere cloud of transient particles—a meteor-flock, as Mr. Proctor imagines.

Apart from the difficulty of supposing such a multitudinous and continual supply of meteoric matter as this theory would require, and neglecting all consideration of the peculiar form assumed by this envelope, which seems to be deepest precisely over those solar latitudes where the spots and prominences are most numerous, and even to be governed in the minutiæ of its outline by the position of its prominences, I find what seems to me an almost insuperable objection to it in the powerful winds and cyclones which prevail in the region above the chromosphere at elevations of from 50,000 to 100,000 miles.

These winds, by which the tops of the solar flames are whirled and driven, present, so far as observations now go, every characteristic of true aerial currents in a continuous medium; and the whole appearance and behavior of the solar protuberances, except at the moment of eruption, is that of clouds floating in an air.

But if we then consider the leucosphere as a true solar atmosphere, how can we reconcile its enormous extent with the known smallness of the pressure at its base, determined by the experiments of Lockyer, Frankland, and Wullner? In either of two ways; first, and perhaps on the whole most probably, this atmosphere may consist of some new kind of matter whose density is far below that of even hydrogen; or it may be composed of matter whose specific *gravity* (*not density*) is diminished, annihilated, or even rendered negative by some such solar repulsion as appears to be operative in the formation of a comet's tail.

There is no doubt that the line which characterizes its spectrum coincides with one of the lines of the *Iron* spectrum within the limits of any present means of observation: and so close a coincidence can hardly be accidental. And yet in the spectrum of iron, this line is only a faint and unimportant one—one of the last to make its appearance under the stimulus of the electric spark, and so little comparable in intensity with many others in its immediate neighborhood, that Mr. Huggins failed to map it on his spectral chart.

It is certainly difficult to understand how, if this line be really of the same origin as its fellows, it should remain the sole survivor of changes which have been able to exterminate from the spectrum all its more conspicuous associates; and accordingly, from this point of view, it becomes natural to suppose, as I suggested in 1869, that when the line appears in the spectrum of iron it may be due not to the iron itself, but to some associated substance (possibly standing in relation to the peculiar magnetic properties of this remarkable metal)—some occluded gas, which can also exist free in a state of inconceivable tenuity, as we have it in the leucosphere, and probably also in the streamers of the aurora, and in the tails of comets*—a near relative, so far as gravity is concerned, to the luminiferous ether and to the Urstoff of German speculators.

The view of Mr. Lockyer agrees with this in supposing the leucosphere to consist of some new form of matter.

On the other hand, it is to be noted that alterations of pressure and temperature do produce in known spectra great changes, somewhat such as would be required in order to reduce the complicated spectrum of iron to this one line. (But I do not know of any case where one of the unimportant lines is the last to disappear.)

* It is perhaps worthy of remark that in the spectrum of Brorsen's comet, as given by Mr. Huggins, the position of one of its three bands appears to coincide with 1474, so far as can be judged from the figure and the measurements, which, however, do not permit any very rigid testing of the matter. It seems somewhat probable that this same line will be observed in the spectrum of the tail of the first bright comet offered to observation.

Furthermore, those other lines of iron, which are often seen in the chromosphere spectrum, are nearly all of about the same order of prominence as 1474. The more conspicuous iron lines seldom if ever appear reversed, while in the case of other substances their strongest spectral lines are always the first to turn bright.

If then we admit a sufficient repulsive force, it seems still possible to suppose that the leucosphere may consist of iron in the state of vapor and fog; and the well known wide diffusion of this metal in meteoric matter makes it comprehensible how its lines should occur in the spectrum of our own terrestrial aurora, and in any other places where they may be found.

Possibly future researches in the laboratory may throw clearer light upon the subject.

It is hardly necessary to add that our own terrestrial atmosphere, *when clear*, appears to me to play only a very subordinate part in the phenomenon. Some influence it must, of course, have; but remembering how much the inner portion of the coronal ring exceeds in brilliance the outer, it would seem that the illumination of the lunar disc must give us an exaggerated measure of the true atmospheric effect. This illumination makes the edge of the moon only enough brighter than the center to give it the appearance of a globe, but of almost inky blackness.

With the subjective element, the case is very different. In untrained observers especially, it may be so influential that two intelligent persons standing side by side will describe and even sketch upon paper appearances most grotesquely different from each other and from the truth.

Even skilled observers are greatly affected by the strangeness and peculiar nature of the phenomenon, and the excitement of the occasion.

Hanover, March 23d, 1871.

Art. XLVII.—*On the supposed Legs of the Trilobite, Asaphus platycephalus;* by James D. Dana.

At the request of Mr. E. Billings of Montreal, I have recently examined the specimen of *Asaphus platycephalus* belonging to the Canadian Geological Museum, which has been supposed to show remains of legs. Mr. Billings, while he has suspected the organs to be legs so far as to publish on the subject,* has done so with reserve, saying, in his paper, "that the first and all-important point to be decided, is whether or not

* Q. J. Geol. Soc., No. 104, p. 479, 1870, with a plate giving a full-sized view of the under surface of the trilobite, a species that was over four inches in length.

the forms exhibited on its under side, were truly what they appeared to be, locomotive organs." On account of his doubts, the specimen was submitted by him during the past year to the Geological Society of London; and for the same reason, notwithstanding the corroboration there received, he offered to place the specimen in my hands for examination and report.

Besides giving the specimen an examination myself, I have submitted it also to Mr. A. E. Verrill, Prof. of Zoology in Yale College, who is well versed in the invertebrates, and to Mr. S. I. Smith, assistant in the same department, and excellent in crustaceology and entomology. We have separately and together considered the character of the specimen, and while we have reached the same conclusion, we are to be regarded as independent judges. Our opinion has been submitted to Mr. Billings, and by his request it is here published.

The conclusion to which we have come is that the organs are not legs, but the semi-calcified arches in the membrane of the ventral surface to which the foliaceous appendages, or legs, were attached. Just such arches exist in the ventral surface of the abdomen of the Macrura, and to them the abdominal appendages are articulated.

This conclusion is sustained by the observation that in one part of the venter three consecutive parallel arches are distinctly connected by the intervening outer membrane of the venter, showing that the arches were plainly *in the membrane*, as only a calcified portion of it, and were not members moving free above it. This being the fact, it seems to set at rest the question as to the legs. We would add, however, that there is good reason for believing the supposed legs to have been such arches in their continuing of nearly uniform width almost or quite to the lateral margin of the animal; and in the additional fact, that, although curving forward in their course toward the margin, the successive arches are about equidistant or parallel, a regularity of position not to be looked for in free-moving legs. The curve in these arches, although it implies a forward ventral extension on either side of the leg-bearing segments of the body, does not appear to afford any good reason for doubting the above conclusion. It is probable that the two prominences on each arch nearest the median line of the body, which are rather marked, were points of muscular attachment for the foliaceous appendage it supported.

With the exception of these arches, the under surface of the venter must have been delicately membranous, like that of the abdomen of a lobster or other macruran. Unless the under surface were in the main fleshy, trilobites could not have rolled into a ball; and the fact that this particular species of Asaphus is not found so rolled may be owing to the unusual size or firmness, and also the position, of these slender arches.

ART. XLVIII.—*Description of some new Fossil Serpents, from the Tertiary Deposits of Wyoming;* by Professor O. C. MARSH, of Yale College.

AMONG the Reptilian fossils discovered by the Yale College party, during their explorations last summer in the Green River Tertiary basin, west of the Rocky Mountains, were the remains of several species of Serpents, which are of peculiar interest, as they are the first extinct Ophidians found in the interior of the continent, and, with the exception of three species from the Eocene marl of New Jersey,* the only fossil representatives of this order yet detected in this country.

These remains, which are now in the Peabody Museum of Yale College, consist mainly of vertebræ, of various sizes, many of them more or less injured, but in general with the most characteristic parts well preserved. Nearly all the specimens obtained evidently belonged to constricting serpents, closely related to the modern Boas of South America, although considerably smaller, and generically distinct. A few of the specimens indicate snakes of moderate size, with apparently quite different affinities.

In comparing the larger series of these fossil vertebræ, especially those from near the middle of the trunk, with the corresponding vertebræ of the living species of *Boa*, a strong resemblance will be noticed in the more important characters, especially in the transversely elliptical outline of the articular cup and ball; in the obtuse lateral elevation extending from the diapophyses to the articular ball; and in the elongated median ridge on the inferior surface of the centrum. The differences between them, however, are important, and indicate clearly that the fossil specimens represent a separate genus, for which the name *Boavus* † is proposed, in allusion to the not improbable relationship of the two types. In the extinct genus, the articular ball and cup are more nearly vertical, and their outline forms a more full transverse ellipse. The neural arch is proportionally more elevated, and has on either side a low ridge, extending backward from the articular face of the zygosphene, and expanding over the zygantral cavities. The latter are more deeply excavated than in *Boa*. The neural spine is shorter, its antero-posterior extent, in the specimens in which it is preserved, being greater than its height. The diapophyses are convex throughout, while those of *Boa* are more or less concave on the lower part of their articular face. The lateral elevation, extending from the diapophyses to the articular ball, is, in *Boavus*, situated lower on

* This Journal, vol. xlviii, p. 397, Nov. 1869.

† *Boa*, and *avus*, grandfather.

the centrum, and is less rounded. The hypapophysial ridge, also, is sharper, and extends nearer to the inferior edge of the articular ball.

From the vertebræ of *Dinophis* Marsh, which genus includes the only fossil Ophidians hitherto found in this country, as well as from those of the nearly allied *Palæophis* of Owen, the specimens of *Boavus* here described are widely separated, especially by their greatly inferior size; by the shorter neural spine; by the broader zygosphene, which exceeds in transverse diameter the articular cup, as in most modern serpents; by the elevation extending backward from the zygosphene; by the more expanded diapophyses; and by the well developed lateral and inferior median ridges on the centrum. The vertebræ of *Boavus*, however, resemble those of *Palæophis* and *Dinophis*, and differ from those of *Boa*, *Crotalus*, and many other modern serpents, in having the sides of the neural canal extended forward nearly to the edge of the articular cup.

Boavus occidentalis, sp. nov.

This species is established on eight vertebræ, nearly all from the middle dorsal region. They evidently represent several individuals, as they differ considerably in size, and were found at three separate localities. They indicate constricting serpents between six and eight feet in length. The neural arch in this species is elevated and massive. The neural spine is short, and triangular at its base, which rests on the posterior three-fourths of the arch. The zygosphene is convex above, slightly excavated in front, and without a median tubercle. The neural canal has a distinct median epapophysis on its floor, and sharp lateral ridges, which give it a sub-trifoliate outline. The diapophyses are auriform, and project below the inferior margin of the cup. The hypapophysis is a sharp ridge, beginning at the margin of the cup, and ending, just before reaching the ball, in an obtuse projection.

The principal dimensions of one of the largest vertebræ of this species are as follows:—

Length of centrum from edge of cup to convexity of ball,	4·50	lines.
Transverse diameter of cup,	2·80	"
Vertical diameter of cup,	2·50	"
Transverse diameter of zygosphene at base,	3·50	"
Distance from top of zygosphene to lower margin of cup,	5·	"
Vertical diameter of ball,	2·45	"
Width of neural canal in front,	1·75	"
Height of neural canal in front,	1·10	"

The various specimens representing this species were found in September last by H. B. Sargent, A. H. Ewing, and the

writer, at Grizzly Buttes, near Fort Bridger, Wyoming Territory. The geological horizon is probably Eocene.*

Boavus agilis, sp. nov.

This species, which was nearly the same in length as the preceding, although apparently much more slender, is indicated by five vertebræ, all from the dorsal region, and representing two or more individuals. They may readily be distinguished from the corresponding vertebræ of *B. occidentalis*, by the proportionally more elongated centrum; by the rounder and more inclined cup; by the more expanded anterior zygapophyses; by the diapophyses, which do not extend below the inferior surface of the centrum; and by the hypapophysial ridge, which is more obtuse, and in its anterior portion expands rapidly until it disappears in the margin of the cup.

The largest vertebra of this series has the following dimensions:—

Length of centrum from edge of cup to convexity of ball,	4·25 lines.
Transverse diameter of cup,	2·50 "
Vertical diameter of cup,	2·40 "
Vertical diameter of ball,	2·35 "
Width of neural canal in front,	1·75 "

The specimens on which this species is based were discovered by the writer, near Fort Bridger, in the same formation as the remains above described.

Boavus brevis, sp. nov.

The serpents representing this species were considerably smaller than those described above, and evidently much shorter in proportion to their bulk, being probably not more than four or five feet in length. The only remains obtained consist of three dorsal vertebræ, all in good preservation, and evidently belonging to two different individuals. These vertebræ have the centrum unusually short, its extent measured on the inferior surface scarcely exceeding the transverse diameter of the zygosphene. The neural arch is low, and bears on its posterior two-thirds the neural spine, which is quite short, and truncated. The zygosphene is less massive than in the preceding species, and has a slight median swelling on the anterior margin of its base.

The dimensions of the most perfect of these vertebræ are as follows:—

Length of centrum from edge of cup to convexity of ball,	2·20 lines.
Transverse diameter of cup,	1·60 "
Vertical diameter of cup,	1·25 "
Transverse diameter of zygosphene at base,	1·85 "
Distance from top of zygosphene to lower margin of cup,	2·80 "
Width of neural canal in front,	1·00 "
Height of neural canal in front,	·90 "

* This Journal, III, vol. i, p. 192, March, 1871.

The specimens here described were found by H. B. Sargent, in the same fresh-water Tertiary deposits, and near the same locality, as the two preceding species.

Lithophis Sargenti, gen. et sp. nov.

This species and genus are at present represented by three trunk vertebræ, only one of which, however, is sufficiently well preserved to show all its more important characters. The specimens indicate a small serpent about four feet in length, and probably, like the preceding species, allied to the constrictors. From the vertebræ of *Boavus*, as well as from those of the other fossil Ophidians discovered in this country, the present specimens may be readily distinguished by the more compressed centrum, and especially by the articular cup and ball, which are circular in transverse outline, as in the Arican *Eryx*, and stand nearly at right angles to the axis of the centrum. The anterior zygapophyses, also, are more extended outward, and their articular faces have a greater antero-posterior expansion than in any of the described species. The diapophyses have their articular surfaces divided by a horizontal groove, having a rounded tubercle above, and a pointed projection below, as in the modern *Bascanion*. There is no lateral ridge extending from the diapophyses to the articular ball, as in *Boa* and *Boavus*, the converging sides of the centrum being nearly flat. The hypapophysis is reduced to a wedge-shaped ridge, extending the whole length of the centrum, and having its sharp apex below the inferior margin of the cup. The floor of the neural canal has a prominent, obtuse median ridge throughout its whole length, but no lateral ridges are apparent.

The principal measurements of the best preserved vertebra are as follows:

Length of centrum from edge of cup to convexity of ball,	2·80 lines.
Transverse diameter of cup,	1·35 "
Vertical diameter of cup,	1·35 "
Vertical diameter of ball,	1·30 "
Width of neural canal in front,	·90 "
Distance from end of anterior zygapophysis to hypapophysis,	3·00 "
Distance between ends of the anterior zygapophyses,	4·50 "

For the extinct genus manifestly indicated by the fossils here described, the name *Lithophis** is proposed, and the species they represent may appropriately be called *Lithophis Sargenti*, after the discoverer, Mr. H. B. Sargent, of the Yale Scientific party, who found the specimens in the Eocene "Mauvaises Terres" beds at Grizzly Buttes, near Fort Bridger.

* Λίθος, *stone*, and Ὄφις, *serpent*.

Limnophis crassus, gen. et sp. nov.

One of the most interesting of the Ophidian fossils obtained during our explorations in Wyoming was a single anterior dorsal vertebra, very well preserved, and quite unlike any hitherto described. It indicates a moderately sized constricting serpent, perhaps six feet in length, but evidently of a very different type from the species already characterized. On comparing it with the corresponding vertebræ of *Boavus* and *Lithophis*, a striking difference is at once seen in the dimensions of the articular cup, which considerably exceeds in width the parallel diameter of the base of the zygosphene, a feature only observed heretofore in a few fossil serpents from the Eocene, and quite unknown in modern species. The cup and ball have a subtriangular, ovate outline, the greatest transverse diameter being above the center: they are also placed nearly at right angles to the axis of the centrum. Another marked peculiarity of this vertebra is the unusual posterior extension of the neurapophyses, which project some distance beyond the articular ball. Their nearly flat sides slope downward and outward like a gable roof, without any indication of the angle so characteristic of the vertebræ of Palæophis,* which in several other respects the present specimen strongly resembles. The neural spine is unfortunately not preserved, but it was evidently short, and confined to the posterior two-thirds of the neural arch. The anterior zygapophyses had only a moderate expansion. The diapophyses have, for the attachment of the rib, a single, rounded, and prominent tubercle, with its lower border above the inferior margin of the cup, and with no indication of a dependant process. There is also no ridge extending from the diapophysis to the articular ball. The hypapophysis consists of a single, compressed, obtuse tubercle, which descends from the middle of the centrum downward and slightly forward; its base occupying rather more than half of the median line.

The more important dimensions of this vertebra are as follows:

Length of centrum from edge of cup to convexity of ball,	3·20	lines.
Transverse diameter of cup,	2·30	"
Vertical diameter of cup,	1·80	"
Vertical diameter of ball,	1·70	"
Distance from posterior summit of neurapophyses to inferior margin of ball,	3·50	"
Length of hypapophsis below inferior margin of cup,	·90	"

This interesting vertebra, although the only one of the kind at present known, is so characteristic, and well preserved, and differs so widely from the corresponding remains of Ophidians

* Memoirs of Paleontological Society of London, 1850, p 57.

hitherto described, as to justify establishing for its reception a new genus, which may be called *Limnophis.** The species may properly be named *Limnophis crassus*, in reference to the probable proportions of the extinct serpent thus indicated. The specimen was discovered by Mr. A. H. Ewing, a member of the Yale party, in the Eocene fresh-water deposits, near Marsh's Fork, about fifteen miles from Fort Bridger, in Wyoming.

Yale College. New Haven, March 20th, 1871.

ART. XLIX.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School. No.* 14.—*On the Estimation of Phosphoric Acid;* by CHARLES E. MUNROE.

§ 1. THOUGH the methods commonly in use for the quantitative determination of phosphoric acid are capable in most cases of giving accurate results, yet it will, I think, hardly be claimed for them, that they render new methods unnecessary, and I have therefore undertaken the following investigation in the hope of adding something of value to our analytical resources.

My attention was first called to the employment of ferric chloride with the addition of sufficient mercuric oxide to neutralize the excess of acid. Free mercuric oxide was first added directly, but, as a complete separation could not be effected in this manner, it was found more advantageous to produce the oxide in the solution itself. This was accomplished by first adding mercuric chloride and then potassic or sodic hydrate. As sodic hydrate† can be obtained in commerce absolutely pure this was employed. The precipitate, consisting of ferric phosphate and ferric and mercuric oxides was then evaporated to dryness in the manner recommended by Chatard,‡ filtered and washed on the Bunsen pump.§ Unhappily the phosphoric acid redissolved after evaporation to dryness and the process was therefore abandoned. Bunsen's delicate test with magnesium wire was used throughout the work, sometimes in connection with ammonic molybdate, for the detection of phosphoric acid.

* Λίμνη, *lake*, and Ὄφις, *serpent*.

† The article used was manufactured in England by the direct oxidation of metallic sodium.

‡ This Journal, vol. iv, p. 247.

§ A simple modification of the Bunsen pump may be obtained by connecting a piece of glass tubing, by means of rubber, with a Bunsen funnel. A funnel holding 50 c.m.³ connected with a piece of glass tubing one meter in length emptied itself five times while another funnel of the same capacity, arranged as usual, did so but once. The pressure was so great that the filter had to be protected with a platinum point to prevent it from giving way.

I next studied the behavior of aluminic oxide toward phosphoric acid, and this time met with better success.

The following course was pursued. To the boiling phosphate solution a weighed quantity of pure aluminic sulphate, previously dissolved, was added. A solution of mercuric chloride was then added, and finally sodic hydrate until a precipitate of mercuric oxide was obtained which remained undissolved. In order to hasten the operation the precipitate was allowed to settle and the supernatant liquid poured upon the filter. The gelatinous precipitate was then evaporated to complete dryness as before mentioned, filtered, ignited and weighed. The increase of weight, over that of the aluminic oxide used, was phosphoric oxide. It was found extremely difficult to burn the filter. Care must be taken that for every gram of phosphoric oxide at least two grams of aluminic oxide are added.

The percentage of aluminic oxide, in the sulphate used, was determined by ignition, ammonic carbonate being used to drive off the last traces of sulphuric oxide. The following results were obtained:

(1) ·7320 grms. $Al_2(SO_4)_3 . 18H_2O$ gave ·1310 grms. Al_2O_3 = 17·89 p. c.
(2) ·7100 " " " ·1270 " " = 17·87 "
Mean 17·88.

Anhydrous disodic phosphate was the first salt treated. In order to work with greater rapidity a solution of known strength was prepared of which 50 c.m.^{3} corresponded to ·6195 grms. of phosphate. This gave the following results:

(1) ·6195 grms. gave ·3099 grms. P_2O_5 = 50·02 p. c.
(2) ·6195 " " ·3100 " " = 50·03 "
(3) ·6195 " " ·3097 " " = 50·01 "
(4) ·6195 " " ·3097 " " = 50·01 "
Mean 50·02. Theory 50·00.

Ammonio-sodic phosphate ($Na(NH_4)HPo_4, 4H_2O$) was next analyzed. The amount of phosphoric oxide in the salt was found by igniting it and weighing the sodic metaphosphate.

(1) 1·4650 grms. gave ·6172 grms. $NaPO_3$ = 29·32 p. c. P_2O_5
(2) 1·5017 " " ·6344 " " = 29·40 " "
Mean 29·36.

By the alumina process the following results were then obtained.

(1) 1·5405 grms. gave ·4514 grms. P_2O_5 = 29·30 p. c.
(2) 1·2610 " " ·3707 " " = 29·39 "
(3) 1·1355 " " ·3321 " " = 29·29 "
Mean 29·33.

Calcic phosphate did not give good results by this process on account of the difficulty of washing out the calcic sulphate formed. I succeeded no better with ammonio-magnesic phosphate doubtless because some of the magnesia went down with

the alumina. These experiments are sufficient to show that phosphoric acid may be determined with extreme precision in the alkaline phosphates by the method above given, but the method applies with advantage only to these salts. On the other hand it must be remembered that many phosphates may be decomposed by fusion with the alkaline carbonates and the phosphoric acid then determined as above, so that in fact the method applies in perhaps the greater number of cases which occur in practice.

§ 2. Rose's* method for the separation of phosphoric acid by means of mercurous nitrate and subsequent estimation in the form of pyrophosphate of magnesia has been much used. It will, however, be acknowledged that it has some serious defects. It is tedious, the many operations required increase the chances of error, and the fusion of mercurous phosphate with the mixed carbonates exerts, according to Rose, a sensible action upon the platinum crucible. Nevertheless the perfect separation which it gives is a strong recommendation of the method.

It appeared possible that a valuable modification of this process might result from the addition of mercuric oxide in the manner already employed in the alumina process above described.

The experiments were executed in the following manner. To a boiling solution of the phosphate mercurous nitrate was added in slight excess. This threw down a lemon-yellow colored, crystalline precipitate of nitro-mercurous phosphate which adhered to the sides of the beaker when touched by the stirring rod. Mercuric nitrate was then added and finally sodic hydrate until a slight precipitate of mercuric oxide was obtained which remained undissolved. The mixture of the two salts was found to be insoluble in both hot and cold water, and to wash like sand.

The next step was to find a readier means of treating the nitro-mercurous phosphate.

It was first proposed to dissolve the washed and dried precipitate in chlorhydric acid and titrate with potassic permanganate so as to oxidize the mercurous to the mercuric salt. This process failed. The salt was then treated with sulphuric acid. The final reaction was perfectly sharp, but the results were not satisfactory.

These results having proved that nothing was to be gained in that direction, I tried to remove the mercury by decomposing the nitro-mercurous phosphate with nitric acid and precipitating the mercury with sulphydric acid or ammonic sulphide. The phosphoric acid was then to be determined in the filtrate by the ammonio-magnesian solution. On examining the mercurous

* Traité de Chimie Analytique, ii, 708.

sulphide it was found that some of the phosphoric acid was always precipitated with it. Its presence was proved by Bunsen's test with the magnesium wire. The salt was then dissolved in a solution of potassic cyanide and a current of sulphydric acid passed through, but with the same result as before. Again it was thought that the phosphoric acid might be precipitated directly from the cyanide solution by ammoniomagnesic chloride, but experiment showed that the cyanide contained so much cyanate and carbonate that, although the solution was boiled and chlorhydric acid was added to it, accurate results could not be obtained.

As the ignition of the nitro-mercurous phosphate with the non-volatile metallic oxides, in order to drive off the mercury, promised well, this process was then tried in the following manner.

The dried salt was thoroughly mixed with a weighed quantity of cupric oxide in a platinum crucible and the filter placed on top. The whole was ignited, at first gently, then to low redness, at the mouth of a muffle,* then cooled, a few drops of nitric acid added to oxidize the cupric oxide reduced by the filter, and then re-ignited. The ignition was continued until the weight became constant. The increased weight was the phosphoric oxide (P_2O_5). After ignition the cupric oxide and phosphate came out of the crucible in a beautiful coherent mass, leaving it perfectly clean and unharmed.

Disodic Phosphate.—It is quite difficult to obtain this salt anhydrous. It becomes so between 30° and 40°, but, as it fuses at 35°, it must be repulverized for analysis, and as it is quite hygroscopic, it is liable to change during the operation. A quantity dried over sulphuric acid was used, the phosphoric oxide being determined by ignition.

						per. ct.	
(1)	1·1130 grms.	gave	·4576 grms.	$Na_4P_2O_7$	=	21·98	P_2O_5
(2)	1·2355 "	"	·5075 "	"	=	21·97	"

The mercurous oxide process with cupric oxide gave the following results.

						Found.	Theory.
(1)	1·0245 grms.	gave	·5124 grms.	P_2O_5	=	50·01	50·00
(2)	1·2198 "	"	·4716 "	"	=	38·66	21·97
(3)	·9200 "	"	·2018 "	"	=	21·93	"
(4)	1·2423 "	"	·2730 "	"	=	21·97	"

Number one was a specimen of anhydrous phosphate. It will be noticed that the second analysis is much too high. In

* Justice is not done the muffle furnace. It gives an even, mellow heat which can be easily regulated, and for igniting precipitates it is unequaled. I have before spoken of the difficulty found in burning the filter with the aluminic phosphate. By placing it at the mouth of the muffle I was able to ignite it in the most perfect manner, without tipping the crucible, in less than ten minutes. Discretion must be used in placing the crucible in the muffle.

this one the nitro-mercurous phosphate was placed in a mass in the center of the crucible and completely covered with cupric oxide. When the crucible was heated the cupric phosphate formed coated the outside of the pellet and prevented the further escape of the mercury. This proves the necessity of mixing thoroughly.

Care should be taken that the mercurous nitrate used is not basic. The salt used in this investigation was prepared in the following way. Pure mercury was dissolved, by aid of gentle heat, in pure nitric acid in a flat, open vessel. More mercury was now added and the whole boiled until every trace of nitrous acid was driven off. The solution was then allowed to crystallize. To the solution formed from these crystals metallic mercury is added to prevent the formation of mercuric nitrate. By this method the salt is obtained perfectly free from mercuric nitrate and the nitrites.

Ammonio-sodic phosphate.—As the ammonia present decomposes the mercurous nitrate, it is well to boil with a little caustic soda until it is driven off. In the first analysis magnesic oxide was substituted for the cupric oxide, but in every other respect the process was the same.

				Found.	Required.
(1)	1·3500 grms.	gave ·3991 grms.	P_2O_5 =	29·56	29·36
(2)	·9832 "	" ·2902 "	" =	29·51	"
(3)	1·0803 "	" ·3181 "	" =	29·44	"
		Mean		29·50	

Ammonio-magnesic phosphate.—The solution was freed from ammonia as in the previous case. By ignition the following results were obtained.

(1)	·5936 grms.	gave ·3664 grms.	$Mg_2P_2O_7$ =	43·00 pr. ct. P_2O_5
(2)	·6135 "	" ·4123 "	" =	42·99 " "

By the mercurous nitrate process I obtained the following results:

(1)	1·0785 grms.	gave ·4627 grms. =	42·92 pr. ct. P_2O_5
(2)	·9500 "	" ·4084 " =	42·98 " "
		Mean	42·95

Calcic phosphate.—This salt was obtained by precipitating calcic chloride with an excess of disodic phosphate. The precipitate was then carefully washed and dried. This was dissolved in as little nitric acid as possible. If the solution is too acid the precipitate is not formed until sodic hydrate is added. The nitro-mercurous phosphate was ignited with magnesic oxide. By this means the following results were obtained:

(1)	·6190 grms.	gave ·1606 grms. P_2O_5 =	25·94 pr. ct.
(2)	·6765 "	" ·1755 " " =	25·96 "
		Mean	25·95

Mr. Waldo Lincoln employed this process in making an analysis of bone earth, and permits me to cite his results. The nitro-mercurous phosphate was ignited with cupric oxide.

	I.	II.	III.	IV.
Wt. taken	·5586	·4312	·7025	·6969
" SiO_2 found	·0009	·0007	----	----
" P_2O_5 "	·2367	·1487	·2421	·2396
Per cent SiO_2	0·16	0·16	----	----
" P_2O_5	42·37	34·48	34·46	34·38

Mean of P_2O_5 in three analyses, 34·44

The first analysis presents another instance of failure on account of the precipitate not being properly mixed with the cupric oxide.

Aluminic phosphate.—This was prepared by adding an excess of disodic phosphate to a solution of potash alum. The precipitate thus obtained was carefully washed and dried. The phosphate was dissolved in the least possible quantity of nitric acid and then treated as in the previous cases. An excess of nitric acid must be carefully avoided. The precipitate was ignited with cupric oxide.

(1) ·5685 grms. gave ·1634 grms. P_2O_5 = 28·77 pr. ct.
(2) ·5827 " " ·1672 " " = 28·69 "
(3) ·6720 " " ·1927 " " = 28·68 "

Mean 28·71

In order to test the process thoroughly it was thought best to determine the composition of this salt and then to compare the found with the calculated percentage. The water was estimated by simple ignition.

(1) ·8689 grms. gave ·2624 grms. H_2O = 30·18 pr. ct.
(2) ·8370 " " ·2525 " " = 30·17 "

The aluminic oxide was taken by difference yielding 41·12 pr. ct. These results lead to the formula

$$(Al_2O_3)_2(P_2O_5)+8H_2O$$

or $$Al_2O_3+Al_2P_2O_8+8H_2O$$

showing it to be a basic aluminic phosphate.

	Calc. pr. cts.	Found pr. cts.
P_2O_5	28·86	28·71
H_2O	29·27	30·17
Al_2O_3	41·87	41·12

I attempted to determine ferric and uranic phosphates in the same way, but on the addition of the sodic hydrate the metallic oxides were precipitated, rendering this method worthless for them. The iron solution was then very largely diluted and precipitated without the addition of sodic hydrate, but all of the phosphoric acid could not be thrown down. Next the

ferric was reduced to the ferrous salt by the addition of metallic iron, by passing a stream of sulphydric acid through the solution, and by the addition of sulphurous acid, but without better results. The phosphate was dissolved in potassic cyanide and the ammonio-magnesian solution added to precipitate the phosphoric acid. I hoped that potassic ferrocyanide would be formed which would remain in solution and allow the phosphoric acid to combine with the potassium. The experiment, however, proved unsuccessful, and with these results the further investigation of ferric phosphate was suspended.

Although the ignition with cupric oxide leaves nothing to be desired in point of accuracy, and is a much quicker method than any now in use, yet it was thought that some other agent might be employed which would hasten the process still more.

Stannic oxide was tried for this purpose. To a weighed quantity of pure tin* the nitro-mercurous phosphate was added, then sufficient nitric acid, sp. gr. 1·170, was poured upon the mass to oxidize the tin completely. The whole was evaporated to dryness on a radiator, ignited and weighed. The plan seemed very promising, but the results, from some unknown cause, were far from being satisfactory.

Another idea was to fuse the nitro-mercurous phosphate with some substance which had a low fusing point, so that the mercury might be volatilized, the phosphoric oxide remaining. Accordingly it was fused with free sulphur but some of the phosphoric oxide was always volatilized. Potassic dichromate and plumbic chromate were both subjected to trial, but as the results were very unsatisfactory, further investigation in this direction was abandoned.

These results prove conclusively the value of this process for the estimation of phosphoric acid in all cases except those of ferric† and uranic phosphates.

* Chemically pure tin can be obtained in considerable quantities, and with very little trouble, in the following manner. Ammonio-stannic chloride is first produced by adding to one molecule of stannic chloride, two of sal ammoniac. Dissolve in the least possible quantity of water and add an excess of chlorhydric acid, which causes the double chloride to crystallize out immediately. Purify completely by recrystallization from acid solutions. Dry the salt at 120°. Then fuse with an equal weight of a mixture of one part of potassic cyanide and one of potassic carbonate in a porcelain crucible On cooling a button of chemically pure tin will be found.

† Rose proposes in the case of ferric phosphate, to fuse the mercurous phosphate obtained with the mixed carbonates; then dissolve in dilute chlorhydric acid, and precipitate with the ammonio-magnesian solution. This will not effect a complete separation.

Otto's process of precipitating the phosphoric acid as ammonio-magnesic phosphate in the presence of tartaric acid was modified and tested as follows: Ferric phosphate was prepared by precipitating ferric chloride with disodic phosphate. The precipitate was thoroughly washed by decantation and then evaporated to dryness. By this means the phosphate was obtained as a light yellow powder. A weighed quantity of this was dissolved in dilute chlorhydric acid, sufficient tartaric

§ 3. *On the use of Porous Cones in Filtration.*

The sulphides of arsenic and antimony being quite easily obtained have long been regarded as furnishing the readiest and best means for the estimation of these two elements. A serious objection has however arisen in the fact, that they must be determined upon weighed filters, and that paper filters cannot be dried above 100° without danger of loss. Hence a filter which could be weighed easily and withstand a high temperature became a desideratum.

Taylor* accomplished this with sand filters, and obtained some excellent results. This method, however, requires experience and careful manipulation, reasons which will probably prevent its being generally used.

Under these circumstances the idea of using a cone made of very porous earthenware, and as a substitute for the paper filter, presented itself to me, and has been carried out in the following manner.

acid added to keep the whole of the iron in solution, next ammonia in excess, the solution was then heated till it boiled briskly, and the ammonio-magnesian solution was added. The precipitate was ignited and weighed as magnesic pyrophosphate. This method gave the following results.

(1)	·6084 grms.	gave	·3437 grms.	$Mg_2P_2O_7$	=	36·13	per cent.	P_2O_5
(2)	·7411 "	"	·4173 "	"	=	36·02	"	"
(3)	1·0294 "	"	·5805 "	"	=	36·11	"	"

Mean 36·09.

I would call especial attention to the fact, as it shortens the process considerably, that the phosphate solution was boiling when the ammonio-magnesian solution was added. Dr. Gibbs found that when the ammonio-magnesic and ammonio-manganic phosphates were precipitated from boiling solutions, that on cooling they came down as beautiful, highly crystalline precipitates, which, instead of requiring twenty-four hours for precipitation, were ready to be filtered within an hour. This method has been in use in this laboratory for the past six months, and has met with uniform success. It applies as well to the estimation of phosphoric acid as to that of magnesium and manganese.

With this additional treatment for the separation of iron, it is believed that this process will apply to the majority of cases met with in practice.

* This Jour. II, vol. xliv, p. 215.

The cones* are made of very light, porous earthenware, and have an angle of about sixty degrees. They are used in the following way:

A section of a seamless rubber tube *a*, is stretched around the mouth of a funnel *b*, preferably a Bunsen funnel, allowing a portion of the tube to project above the top. This part will immediately arrange itself at right angles to the top of the funnel; into the circle thus formed the cone *c*, is put. It is then connected with the Bunsen pump. When the cone is moistened and the pressure applied, the rubber band forms an air-tight joint and the liquid runs through with great rapidity. Before the cones are applied to quantitative work they must be carefully washed, first with concentrated chlorhydric acid, then with distilled water, dried, and weighed. A small porcelain crucible was always kept at the balance in which to weigh them. With this apparatus the following results have been obtained.

A sample of ordinary crystallized potassio-antimonylic tartrate gave

(1) 1·1069 grms. gave ·5570 grms. Sb_2S_3=35·94 pr. ct. Sb.
(2) 1·6985 " " ·8550 " " =35·96 " "
Mean 35·95.†

A specimen of the same salt carefully recrystallized, gave upon analysis the following data.

(1) ·7755 grms. gave ·3955 grms. Sb_2S_3=36·40 pr. ct. Sb.
(2) ·6050 " " ·3085 " " =36·42 " "
Mean 36·41.

Mr. W. Lincoln also made an analysis of the same salt by means of the cones, and kindly permits me to use his results.

(1) ·4683 grms. gave ·2388 grms. Sb_2S_3=36·41 pr. ct. Sb.
(2) ·8135 " " ·4144 " " =36·38 " "
Mean 36·40.

In all of these analyses Sb=120.

The Sb_2S_3 was precipitated in the manner recommended by Sharples.‡ It is necessary that the boiling should proceed for some time, a brisk current of sulphydric acid being passed through the liquid. The precipitate is then filtered upon the weighed cone and the whole dried in an air bath at 300°. The antimonous sulphide is at this temperature converted into the gray crystalline modification.

* Much credit is due to the firm of A. W. & H. C. Robertson of Chelsea, Mass., who, by their superior mechanical skill, have aided me much in accomplishing the desired result.

† Taylor obtained as the mean of three analyses 36·08.

‡ This Jour., II, vol. l, page 248.

No formula has yet been found which agrees with either of the percentages obtained. As the atomic weight of antimony is differently stated from 120 to 122, this is easily explained.

It is unfortunate that the atomic weight of antimony is yet so uncertain, but it is hoped that these results, agreeing so closely among themselves, will be accepted as proving the value of the process.

Arsenous Oxide.—This was the next substance analyzed. The sulphide was precipitated in the usual manner, but it was noticed that by having the solution decidedly acid and passing through it a very rapid stream of sulphydric acid, that the sulphide was obtained in a more granular condition.

The precipitate can be dried with impunity at 120°. At 140° the lemon-yellow sulphide commences to change to red, and at 180° is completely converted into the liver-red variety.

With ordinary commercial arsenous oxide, the following results were obtained.

						Found pr. cts.	Theory pr. cts.	
(1)	1·7940 grms.	gave	2·2260 grms.	As_2S_3	=	75·64	75·76	As.
(2)	·5770 "	"	·7165 "	"	=	75·84	"	"
(3)	·8520 "	"	1·0579 "	"	=	75·68	"	"

Mean 75·72

Mr. Lincoln obtained as the result of two analyses:

						Found pr. cts.	Theory pr. cts.	
(1)	·8926 grms.	gave	1·1087 grms.	As_2S_3	=	75·76	75·76	As.
(2)	·8145 "	"	1·0128 "	"	=	75·77	"	"

Mean 75·76

These results show that this process renders the estimation of antimony and arsenic one of the simplest and most accurate operations in quantitative analysis.

The cones can be used repeatedly and can replace paper filters in every case. They will undoubtedly be found to be of great value in commercial work, for drying crystals and filtering corrosive liquids. As they will stand sudden changes of temperature without breaking, they can be substituted to advantage in many cases for crucibles.

In closing, I desire to return my sincere thanks to my kind teacher, Dr. Gibbs, who has furnished me with the material for these investigations, and has aided me by his counsels and advice.

Cambridge, March 13th, 1871.

ART. L.—*On certain Glacial and Post-glacial phenomena of the Maumee Valley;* by G. K. GILBERT, A.M.

THE observations, upon which the following remarks are chiefly based, were made during the summers of 1869 and 1870 for the Ohio Geological Survey, and are here published, with permission, in advance of the official report.

I. The Maumee occupies a broad shallow valley with easy slopes and without definite boundaries. It is the westward prolongation of the trough occupied by Lake Erie, and includes the upper waters at least of the Wabash river as well as the entire basin of the Maumee. The highest point along the axis of the valley is at Fort Wayne, one hundred miles from Lake Erie, and is but 185 feet above the present level of that lake, so that the descent of the Maumee eastward is less than two feet per mile; the sides of the valley rise with a slope nearly as moderate to an altitude of 300 to 400 feet above the median line. So nearly does it approximate to a plain that the consequences of the earth's sphericity are not cancelled, and an observer on one side is prevented from seeing the opposite by the interference of the intervening land.

The rock surface is covered by a sheet of drift, that masks its minor irregularities and contributes to the general impression of a plain. Where the drift has been freshly removed by the wash of waves or currents, the surface of the underlying rock is shown to be planed, striated, and furrowed by glacial action. The general bearing of the striæ, subject to local deflection from details of contour, is parallel to that of the valley. At Sandusky City, and on Kelley's, South Bass, and West Sister Islands it is S. 80° W.; at Fremont and Genoa, east of Toledo, S. 65° W.; at various points in Lucas county, west of Toledo, S. 55° W.; and along the Auglaize river near Defiance, S.W. Farther south the bearing is still more southerly, being S. 35° W. at Lima, O., and S. 15° W. at Middlepoint near Van Wert. That the motion to which this system of striæ is due was southwestward—up the valley of the Maumee as it now lies,—and not in the opposite direction, is attested by some flint nodules contained in limestones of the Waterlime Group on West Sister island and at Monclova near Toledo. By reason of their superior hardness, they were able to resist, better than the limestone, the grinding action, and they project boldly from the planed surfaces, protecting and maintaining each upon its west or lee side, a train or ridge of undisturbed limestone.

The overlying drift is in chief part a blue clay—the Erie Clay of Sir William Logan—containing irregular, lenticular beds of sand and gravel, and abundant, but unequally dis-

tributed, glaciated boulders of all sizes up to a diameter of twenty feet. It has already been recognized by Dr. Newberry as the sediment of a sea or ocean flanked by glaciers and floating rock-laden icebergs; and every phase that has fallen under my own observation has served to confirm the identification. Its more elevated portions, which have been exempt from lacustrine action, present a rolling surface with frequent, undrained hollows, occupied by lakelets or the deep swamps that have resulted from their slow filling; while at and below the level of 220 feet (above Lake Erie) this surface has been remodelled and levelled by the waves, currents and sediments of Lake Erie.

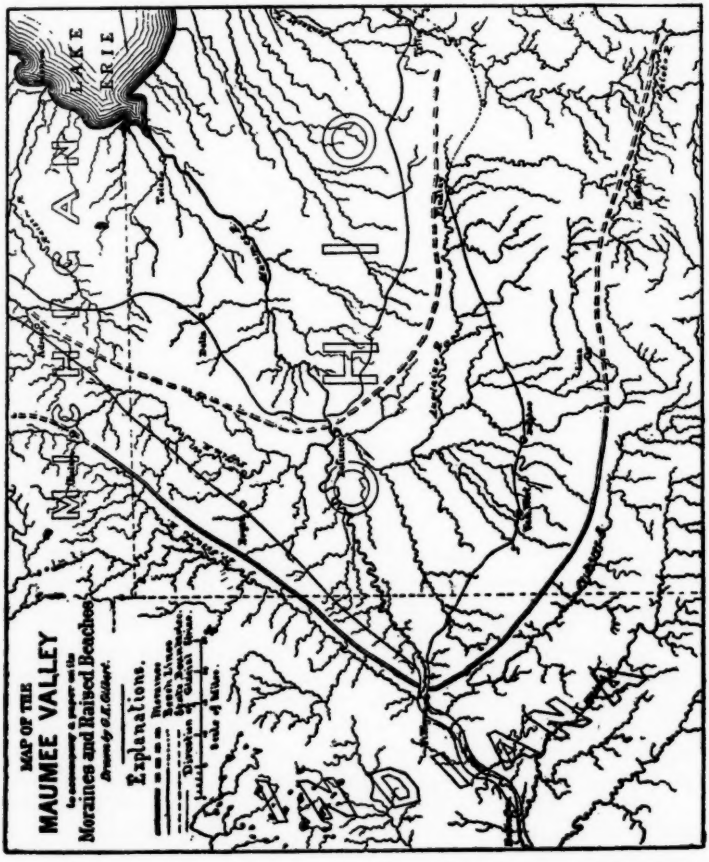
Premising thus much of the general character of the valley, I will now ask the reader to notice, upon the accompanying map, some peculiarities of the arrangement of the watercourses. North of the Maumee river, where the land slopes to the southeast, most of the rivulets flow in that direction; but the principal streams, the St. Joseph and Tiffin rivers, cross the system at right angles. Moreover, all the tributaries of the St. Joseph come from the northwest, while the country east of it is drained by branches of the Tiffin, the divide between the waters of the two streams running within five miles of the former. This feature is caused by a narrow step in the country,—a natural embankment, that carries the St. Joseph across the face of the slope, as a mill-race is carried along the bank of a stream; and that river may be said to result from the confluence of eastward-flowing creeks that have found a barrier in the ridge which forms its eastern bank. The slopes of this ridge are quite gentle and the height is moderate; west of Bryan, where it is crossed by a branch of the Lake Shore and Michigan Southern Railway, it rises to an altitude of fifty feet, while at the north line of Ohio it is barely distinguishable. Superficially it everywhere presents the same rolling gravelly clay as the surrounding country.

South of Fort Wayne the same phenomena are presented by the St. Marys river. The slope of the country is toward the northeast, yet its course is to the northwest. Its tributaries are from the south and west, while its right bank is drained by branches of the Auglaize. Where the dividing ridge has been measured, it has an altitude of 35 to 50 feet.

A correlated feature of the two streams—the St. Marys and St. Joseph—is that, forming the sides of a right angle, they unite at its apex, and the resultant river returns within the angle.

The page of history recorded in these phenomena is by no means ambiguous. The ridges, or, more properly, the ridge which determines the courses of the St. Joseph and St. Marys

rivers is a buried terminal moraine of the glacier that moved southwestward through the Maumee valley. The overlying Erie Clay covers it from sight, but it is shadowed forth on the surface of that deposit, as the ground is pictured through a deep and even canopy of snow. Its irregularly curved outline



accords intimately with the configuration of the valley, and with the direction of the ice markings; its concavity is turned toward the source of motion; its greatest convexity is along the line of least resistance. The notch at Fort Wayne, through which the Maumee flows, was perhaps first cut by the river to which the retiring glacier gave rise, but has certainly been cleaned of the subsequent deposit of clay by a later current,—

to be described farther on. While it affords no section of the moraine for examination, it yet confirms the general fact of its existence, by demonstrating that the superficial ridge has here no nucleus of rock *in situ*. With the exception of the Maumee, no stream crosses the moraine from near Hudson, Michigan, to Fort Amanda, near Lima, Ohio, a distance of 83 miles in a right line and 120 miles on the line of the moraine. Beyond these points I have not traced it, but an inspection of the map suggests that it may be found along the upper waters of the Tiffin and Scioto rivers, as dotted in the accompanying chart. This would increase its length and chord to 200 miles, and 120 miles, respectively.

The courses of the Tiffin and Auglaize rivers are determined by a more easterly, and so more recent, moraine of the same system, but its form is less conspicuous, as this portion of the valley has been greatly modified by lacustrine action. The same agency has obliterated all superficial traces, if any existed, of minor moraines.

South of the St. Marys river are other and numerous moraines accompanied by glacial striæ. Their character and courses have not yet been studied; but their presence carries the mind back to an epoch of the cold period, when the margin of the ice-field was farther south, and the glacier of the Maumee valley was marged in the general mass. As the mantle of ice grew shorter—and, in fact, at every stage of its existence—its margin must have been variously notched and lobed in conformity with the contour of the country, the higher lands being first laid bare by the encroaching secular summer. Early in the history of this encroachment the glacier of the Maumee valley constituted one of these lobes, and has recorded its form in the two moraines that I have described.

II. That Lake Erie formerly had an outlet past Fort Wayne, Indiana, and down the Wabash valley, has for some years been recognized by local observers;* but, as there is reason to believe that the fact is as yet unpublished, an account of it will not be without interest to the public. I was led to make an examination of this outlet by its relation to certain cotemporaneous beach lines that I had occasion to examine and trace in Ohio.

The relation of the waters of the Great Lakes to their shores has undergone a series of changes since it was first established, by the recession or drainage of the iceberg-bearing sea, at the close of the Drift period. Some of these changes appear to have been gradual and others comparatively sudden, while the

* The fact was suggested to me before I visited the locality, by Martin Arrowsmith, Esq., of Farmers' Centre, O., and was realized less perfectly by several gentlemen whom I met in Indiana.

intervals of rest are plainly marked by the beach lines, of which a series is presented near the borders of each of the lakes, outlining their ancient limits. In the Maumee valley four of these periods of rest are distinctly recorded, the water levels being marked at 220, 195, 165 and 90 to 65 feet, above Lake Erie, along the line of the Air Line branch of the Lake Shore and Michigan Southern Railway, running west from Toledo. Two of these beach lines have been traced for some distance across the country, and their courses are marked on the accompanying map. The lower of the two is the one at 165 feet. Lake Erie then stretched sixty miles up the valley to the site of the town of Defiance, covering all that country now known as the Black Swamp. The upper beach is the highest of the series, and records a lake level at Adrian, Bryan and Columbus Grove of 220 feet above the present, of 210 feet at Delphos, and of 205 feet at New Haven, six miles east of Fort Wayne. Toward the latter point the beach lines converge, coming from the northeast and southeast; but, instead of uniting, they become parallel, and are continued as the sides of a broad water-course, through which the Great Lake Basin then discharged its surplus waters. At New Haven this channel is not less than a mile and a half broad, and has an average depth of 20 feet, with sides and bottom of drift. For twenty-five miles this character continues, and there is no notable fall. Three miles above Huntington, Indiana, however, the drift bottom is replaced by a floor of Niagara limestone, and the descent westward becomes comparatively quite rapid. At Huntington the valley is contracted in width to one mile, and is walled, on one side at least, by rock *in situ*. In the eastern portion of this ancient river bed the Maumee and its branches have cut channels fifteen to twenty-five feet deep, without meeting the underlying limestone. Most of the interval from Fort Wayne to Huntington is occupied by a marsh, over which meanders Little river, an insignificant stream whose only claim to the title of river seems to lie in the magnitude of the deserted channel of which it is sole occupant. At Huntington the Wabash river emerges from a narrow cleft of its own carving, and takes possession of the broad trough to which it was once but a humble tributary. The limestone above Huntington is the rocky rim or dam which determined the altitude of the overflow at this point, and is 170 feet above the present level of Lake Erie. Above it the stream must have resembled the Detroit, bearing a smooth surface, but with enough current to excavate its soft bottom somewhat deeply where the marsh and prairie of the Little river now are spread; below, it was more comparable to the Niagara at Buffalo, where it rushes over the outcrop of the Corniferous limestone. At Fort Wayne the St. Joseph and St.

Marys contributed their waters. Their mouths were more than fifty feet higher than now, and the flood-plains of gravel and sand, which they then formed, now flank their valleys as terraces, and can be traced for forty miles toward their sources. When, by the retiring of the lake, they were united, but slight cause was needed to turn them eastward along the level bottom of the deserted channel, and they have now cut their beds so deeply in the drift, that the highest freshets do not connect them with the Little river.

In addition to its general interest, the fact of this ancient, southwesterly lake-discharge is an important element in the study of the nature of the changes, in virtue of which the lakes have stood at so many different levels since the ice-period. The idea suggested by Dr. Newberry (in a paper before the Boston Society of Natural History in 1862), that they may have been due to local, rather than continental, upheaval and depression, receives here strong confirmation. At the point where Lake Michigan once found outlet southward through the Desplaines river,* the rocky barrier is but four feet above the present level of that Lake, and seventeen feet above Lake Erie. A barrier of drift may have existed one hundred feet higher. At the Wabash outlet the rocky rim is 170 feet above Lake Erie, and was probably covered by fifty feet of drift. And at Lewiston, where the Niagara commenced its work, the elevation of the rim is 38 feet higher than the present Lake.†

The order in which these channels were opened and deserted, is not yet known, but whatever sequence is supposed, it is equally evident that the changes that produced it must have involved the tilting and warping of the land. At whatever time the Wabash valley received the discharge, the barriers, east and west, must have been relatively much higher than at present. To restore now the old water level and current at Fort Wayne, we would need, not merely to fill the gorge of the Niagara, and renew the escarpment at Lewiston, but to construct on that escarpment a retaining wall 170 feet high and many miles in length; and, after filling the valley of the Desplaines to the height—one hundred feet—of the adjacent drift hills, another hundred feet would be needed to complete the dam. Just what has been the warping of the basin to produce this contortion of the rim, I am not prepared to say, but the

* This outlet is described by Dr. E. Andrews in his recent paper on "The North American Lakes considered as chronometers of post-glacial time" (Trans. Chicago Acad. Sci., vol. ii, p. 14); and the additional data here given in regard to it were kindly furnished me, by the same gentleman, in a private letter.

† Nat. Hist. of New York, Geology of Fourth District. By James Hall, p. 384. It is interesting to note, in passing, that the containing rock was in each case the Niagara limestone, and that a deep gorge has been cut at Niagara only, because there alone was an underlying softer rock exposed.

problem is not insoluble. The lines of bluffs, shingle, ridges and dunes, that mark the limits of the water at its various stages, are plain and faithful records, and their tracing cannot fail to throw light on the character and the order of the undulations which have affected the valley of the lakes in post-glacial time. The field for exploration is large, and the data already accumulated inconsiderable, but we may hope the geological surveys now in progress in Ohio, Indiana and Michigan, and in Canada, will in a few years develop the whole subject.

ART. LI.—*Memorandum on the Amphipleura pellucida;* by J. J. WOODWARD, Assistant Surgeon, U. S. Army.

THE attention of microscopists has frequently been directed, of late years, to the *Amphipleura pellucida* or *Navicula acus*, as a test object well suited to try the defining powers of the very best object glasses. The length of this diatom is stated by Pritchard as ranging from $\frac{1}{1400}$th to $\frac{1}{3000}$th of an inch. The average length is given by the Micrographic Dictionary at ·0044 of an inch. The striæ, which are exceedingly difficult, were first described by Messrs. Sollitt and Harrison, who estimated them at from 120,000 to 130,000 to the inch. Their estimate has been adopted by the Micrographic Dictionary and by the majority of modern writers who have referred to this test; but so many difficulties beset the resolution that few microscopists appear to have attempted to verify the original estimates. Indeed most observers would seem to have been unsuccessful in their efforts to resolve the Amphipleura even with the best objectives and some have gone so far as to deny the existence of any striæ upon the frustules of this species.

Among the microscopists who claim to have seen the striæ, several would seem to differ from the original estimates of Sollitt and Harrison as to their fineness. Dr. Royston Pigott, whose papers on "high-power definition" in the Monthly Microscopical Journal have recently attracted much attention, sets down their number at 150,000 to the inch. Dr. Carpenter, on the other hand, in the 4th edition of "The Microscope and its Revelations," expresses the opinion that even the estimates of Messrs. Sollitt and Harrison are too high: and we are told by Mr. Lobb (Monthly Microscopical Journal, vol. iii, p. 104) that Mr. Lealand has recently "succeeded in counting the Amphipleura lines and finds them 100 in $\frac{1}{16000}$th of an inch."

A few months ago two slides of *Amphipleura pellucida* were received at the Army Medical Museum from Messrs. Powell and Lealand, and I succeeded in obtaining excellent resolution

by the immersion $\frac{1}{18}$th of these makers. The frustules on the two slides were found to measure from $\frac{1}{17\frac{1}{2}}$th to $\frac{1}{24\frac{1}{2}}$th of an inch in length. Resolution could be satisfactorily effected and the striæ counted on any of them. I took eight successful negatives from medium size and small frustules, and verified the counts made in the Microscope by counting the striæ on the glass negatives. I found the striæ on medium sized frustules, say $\frac{1}{25\frac{1}{2}}$th of an inch in length, counted usually from 90 to 93 striæ to the $\frac{1}{180}$th of an inch; in that selected for the two photographs which accompany this memorandum the number was 91 to the $\frac{1}{180}$th of an inch. Larger frustules exhibited rather coarser, smaller ones rather finer striæ. On the smallest frustules at my disposal, several of them only $\frac{1}{24\frac{1}{2}}$th of an inch in length, I found no example in which the number of striæ exceeded 100 to the $\frac{1}{180}$th of an inch. The striæ of these smallest and most difficult frustules do not then rival in fineness the nineteenth band of the Nobert's plate, as has been asserted by some; they compare rather with the sixteenth and seventeenth bands.

After making the photographs I extended my observations to a number of other slides of *Amphipleura pellucida* including two of the original specimens from Hull, kindly sent to the Museum some time since by Mr. W. S. Sullivant, of Columbus, Ohio, and the example in the First Century of Eulenstein. I found that different slides varied considerably in the ease with which I could resolve them, chiefly as I think on account of the thickness of the glass covers, which in several instances did not permit the best work of the immersion $\frac{1}{18}$th. Perhaps, however, the markings on some frustules may be shallower than on others whose striæ count the same number to the $\frac{1}{180}$th of an inch. In any event I have found, as yet, no slides the covers of which permit the $\frac{1}{18}$th to be appproximately adjusted, on which it was impossible to resolve the frustules, and no frustules the striæ of which exceeded 100 to the $\frac{1}{180}$th of an inch.

The best resolution I was able to obtain by ordinary lamp light was not very satisfactory. I used therefore, during the investigation, direct sunlight, rendered monochromatic by passage through the solution of ammonio-sulphate of copper. A parallel pencil of such light was concentrated by the achromatic condenser, which was suitably decentred to attain obliquity. The same illumination was employed in making the photographs. I have since had the pleasure of exhibiting the resolution in quite as satisfactory a manner to several microscopists by monochromatic light obtained from the electric lamp.

War Department, Surgeon General's Office,
Army Medical Museum, Feb. 1, 1871.

ART. LII.—*Memorandum on the Surirella gemma;* by J. J. WOODWARD, Assistant Surgeon, U. S. Army.

THE *Surirella gemma* has been recommended by Hartnack as a test for immersion objectives of high powers. I have not gained access to his original description, but find accounts of his views, with figures, in the works of Drs. Carpenter and Frey. ("The Microscope and its Revelations," 4th edition, p. 182. "Das Mikroskop," 3d edition, p. 40.) Hartnack observed fine longitudinal striæ in addition to the fine transverse ones previously known to exist between the large transverse ribs; he supposed the true markings to have the form of elongated hexagons.

Two handsome slides of this diatom were received at the Army Medical Museum a few months since, from Bourgogne of Paris. A careful study of these by monochromatic sunlight inclines me to the opinion that Hartnack's interpretation is erroneous, and that the fine striæ are in reality rows of minute hemispherical bosses; from which, as in the case of other diatoms, the appearance of hexagons would readily result if the frustule was observed by an objective of inferior defining power to that I used, or if the illumination was unsuitable. This memorandum is accompanied by two photographs exhibiting what I saw; one is magnified 1,034, the other 3,100 diameters. The principal frustule shown in these photographs is $\frac{1}{200}$th of an inch in length. (The mean length of *S. gemma* is stated by the Microscopic Dictionary at $\frac{1}{240}$th of an inch.) The fine transverse striæ counted longitudinally at the rate of 72 to the $\frac{1}{1000}$th of an inch. Transversely these were resolved into beaded appearances which counted laterally 84 to the $\frac{1}{1000}$th of an inch. If the structure consists, as I suppose it does, of fine hemispherical bosses, projecting from the surface of the frustules, the fact that these bosses are set together more closely in the transverse direction than in the longitudinal would account for the elongated form of the pseudo-hexagons when seen.

Some parts of the photographs closely approach Hartnack's description, but it is easy to observe that these are not the parts which are most nearly in focus.

I have also resolved this diatom by monochromatic light derived from the electric lamp. The appearances obtained were identical with those above described.

War Department, Surgeon General's Office,
Army Medical Museum, Feb. 1, 1871.

LIII.—*Calorimetric Investigations;* by R. Bunsen.*

(Continued from page 282.)

2. *The Determination of specific heat.*

The simplest way of obtaining the specific heat of a substance is to determine once for all the amount of heat, expressed in scale divisions, which *one* gram of water loses in cooling from 1° C. to 0° C., and to divide by the value W_w thus formed, the quantity of heat W, measured on the same scale, which one gram of the substance loses for the same difference in temperature. If the weight of the substance is G, its temperature t, the number of corrected divisions which the mercury thread of the scale has advanced T, then the specific heat desired results from the equation

$$S = \frac{T}{W_w G t}, \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (6)$$

in which, for t, the boiling point of water, corresponding to the state of the barometer during the experiment, is to be taken.

In order to communicate to substances the constant temperature t, use is made of the apparatus, fig. 4 (p. 173), which is drawn to a scale of $\frac{1}{6}$ of its real size. The tin vessel A, which is provided with a water guage, contains as much water as is necessary in order that, by means of the small gas lamp underneath, a continual jet of steam of 12 hours duration may be produced. The steam enters through the rubber tube *a*, and the outer glass vessel B into the rubber tube *b*, which communicates with an ordinary condenser. Within the vessel B, which is filled with continually renewed steam, is the heating vessel *f*, in the form of an ordinary thin walled test-tube whose upper opening is not widened out but somewhat narrowed and cut off sharply. The opening projects several millimeters above the rubber stopper closing the outer vessel B. When the body to be warmed has remained in the vessel *f*, which is surrounded on all sides by steam, about one hour, then the whole apparatus, through which the steam still flows, is held by means of the cork ring *n*; the still closed mouth *p* is on the likewise closed mouth δ (fig. 1) of the snow-surrounded calorimeter, the stoppers are rapidly removed, while almost simultaneously, by tilting the heating apparatus B, the heated body is allowed to fall into the water *a*, fig 1. The time consumed in falling amounts to only a very small fraction of a second, so that the cooling during the same may be considered as vanishingly small.

On the bottom of the inner vessel *a*, fig 1, is contained a small, perfectly moistened plug of loose cotton wool, which, to

* Translated for this Journal, with permission of the author, from Poggendorff's Annalen der Physik und Chemie, Bd. cxli, by Dr. G. E. Moore, of San Francisco.

prevent its rising, is twisted around a coiled platinum wire. This cotton answers a double purpose: in the first place it prevents the glass vessel from being injured by the falling in of specifically heavy bodies; then in addition it aids in the removal from the apparatus of the substances which have been used in the experiment. To effect this, a properly bent wire is bored into the cotton, which, with the substance resting upon it, is drawn therewith to the mouth of the tube, the substance is removed and the cotton without being taken out of the vessel is returned by means of the wire to its former place.

The principal advantage, which, independent of its great delicacy, the instrument just described possesses over all other calorimetric contrivances is, that the entire heat which the heated body evolves is employed, without any loss, in the ice melting: the weights of the substances which give up their heat to the 0° C. cooled water of the vessel *a*, fig. 1, is so small compared with the weight of this water, that the temperature can never rise to 4° C. As the water has at this temperature its maximum density, the fluid which warms itself on the bottom of the vessel *a* can never rise, and is protected from every loss of heat, not employed in ice melting, by a high superincumbent water column at 0° C., whose conducting capacity for heat is vanishingly small. This circumstance may be observed very beautifully on the ice cylinder, when it has been used for 30 to 40 experiments. There is then to be found in the ice, quite far down on the bottom, where the vessel *a* is rounded off, a hollow space, melted out and filled with water, which possesses the very regular form of a small glass matrass, while the ice cylinder above this part appears throughout its whole extent entirely unaltered.

The weight of the substance to be investigated need be, according to the specific heat to be expected, no greater than 0·3 grams, to at most 4 grams. If the substance is a fluid, or if it is subject to alteration by the access of air or water, it is, as in an organic analysis, sealed in the lightest possible glass case, whose weight is determined in weighing the substance. If the substance floats on water, either above or with the enclosing glass case, it is loaded in addition with a likewise weighed spiral of platinum wire, heavy enough to effect the immersion. It would probably be still more convenient to employ in all cases a light, tightly closing platinum vessel. The amount of heat which the glass case and platinum spiral emit is included in the calculation in the following manner: Let the weight of the glass case be called G_g, its temperature t, and the amount of heat, measured in scale divisions, which one gram of the glass of the case emits on cooling from 1° C. to 0° C. W_g, and

let the same factors for platinum be denoted by G_p, t and W_p, then equation (6) will be transformed into

$$S = \frac{\frac{T}{t} - (W_g G_g + W_p G_p)}{W_g G} \quad \cdot \quad \cdot \quad \cdot \quad (7)$$

The constants W_g, W_p and W_w are first to be determined (once for all), W_p results with the aid of the equation

$$W_p = \frac{T}{Gt}$$

from the following observations, in which G denotes the weight of platinum employed in the experiment:

$$T = 215{\cdot}6$$
$$t = 100°{\cdot}0\ C.$$
$$G = 4{\cdot}5942 \text{ grams}$$

whence: $W_p = 0{\cdot}4692$

W_g was calculated by the same equation from the following observations conducted on two kinds of glass, by which the weight of glass employed in the experiment is denoted by G, and the elements for the determination of T according to equation (5) are likewise given.

TABLE 2.

		Glass, kind I. Expt. 1.	Glass, kind II. Expt. 2.	Glass, kind II. Expt. 3.
Weight of the glass, - -	G	0·5706 grm.	1·0114 grm.	1·4319 grm.
Temperature of the glass, -	t	99°·74 C.	99°·474 C.	99°·474 C.
Duration of the experiment, -	$M_1 - M_0$	29′	87′	56′
Movements on scale before the experiment, - - - - -	$\frac{\tau_0}{m_0}$	−0·1	0·0	+0·005
Movements on scale after the experiment, - - - - -	$\frac{\tau_1}{m_1}$	−0·1	0·0	+0·014
Oscillation on the scale, -	$Q_0 - Q_1$	159·1	287·9	410·4

For the first sort of glass, $W_g = 2{\cdot}7446$;
for the second $W_g = 2{\cdot}8616$
$W_g = 2{\cdot}8777$

Mean $2{\cdot}8697$

W_w is obtained from the two following experiments by means of the equation

$$W_w = \frac{\frac{T}{t} - (W_g G_g + W_p G_p)}{G}$$

TABLE 3.

		Expt. 1.	Expt. 2.
Weight of the water, - -	G	0·3333	0·3333
Weight of the glass case, -	G_g	0·2223	0·2223
Weight of the platinum load,	G_p	0·5230	0·5230
Temperature communicated,	t	99°·474 C.	99°·474 C.
Duration of the experiment, -	M_1-M_0	76′	86′
Movements on the scale before the experiment, - - -	$\frac{\tau_0}{m_0}$	0·0	+0·067
Movements on the scale after the experiment, - - -	$\frac{\tau_1}{m_1}$	0·0	+0·064
Observed divisions on the scale,	Q_0-Q_1	573·9	568·1
Constants, - - -	$W_p=0·4692$; $W_g=2·870$		

The calculation gives: from experiment 1: $W_w=14·660$
" " 2: $W_w=14·654$
in the mean $W_w=14·657$

For the explanation of the method already described, I append the results of several determinations conducted on chemically pure substances, whose specific heat has been determined with great accuracy by the previously customary method of mixture. The elements of observation in these experiments are to be found arranged in the following table 4, whose lettering relates to equations (5) and (7).

TABLE 4.

Substance investigated.		Cast silver.	Cast zinc.	Cast antimony.	Cast cadmium.	Very old roll sulphur
Weight of the substance,	G	3·6320	2·5150	3·8575	1·8675	1·0708
Weight of the glass case,	G_g	0	0	0	0	0
Weight of the platinum load, - -	G_p	0	0	0	0	0
Temperature communicated. - -	t	100°·00 C.	99°·80 C.	99°·80 C.	99°·80 C.	100°·00 C.
Duration of the experiment, - -	M_1-M_0	60′	60′	64′	63′	55′
Movements on scale before the experiment,	$\frac{\tau_0}{m_0}$	0	0	0	0	0
Movements on scale after the experiment,	$\frac{\tau_1}{m_1}$	0	0	0	0	0
Oscillation on the scale,	Q_0-Q_1	297·7	343·8	279·5	146·7	268·8
Constants, -	W=14·657					

In the following table 5, are to be found the specific heats computed from these values, together with the ones found by Regnault by the method of mixture.

TABLE 5.

Substances.	Ice calorimeter. *a.*	Regnault. *b.*	*a*—*b.*
Water, - - -	1·0000	1·0000	....
Silver, - - -	0·0559	0·0570	—0·0011
Zinc, - - - -	0·0935	0·0956	—0·0021
Antimony, - -	0·0495	0·0508	—0·0014
Cadmium, - - -	0·0548	0·0567	—0·0019
Sulphur, - - -	0·1712	0·1764	—0·0052

It will be seen that the values obtained with the ice calorimeter agree very closely with those obtained by Regnault by means of the method of mixture, but have always been found somewhat smaller. Whether this constant deviation has its origin in the difference in the methods employed can be the less decided from these few experiments as they were conducted, to be sure with the avoidance of all considerable sources of error, but without special care, while I was at the same time occupied in other labors.

The following table 6, contains experiments made with several pure elements whose specific heats could not previously be determined. The specific heats and atomic heats calculated therefrom, are arranged together in table 7.

TABLE 6.

Substance investigated.		Indium.	Indium.	Ruthenium.	Calcium.	Calcium.	Allotropic tin.	Cast tin.
Weight of the substance,	G	1·1514	1·1514	1·7927	0·2823	0·2823	2·2394	3·0017
Weight of the glass envelop, - -	G_g	0	0	0·3287	0·6683	0·6683	0·3953	0
Weight of the platinum load, - -	G_p	0	0	0·4239	0·4239	0·4239	0	0
Temperature communicated, - -	t	99°·78 C.	99°·82 C.	99°·60 C.	99°·78 C.	99°·78 C.	99°·786 C.	99°·606 C.
Duration of the experiment, - -	$M_1 - M_0$	46′	47′	106′	65′	76′	66′	65′
Movements on the scale before the experiment,	$\frac{\tau_0}{m_0}$	−0·130	−0·063	−0·160	−0·090	−0·052	−0·120	0·090
Movements on the scale after the experiment,	$\frac{\tau_1}{m_1}$	−0·020	−0·037	−0·110	−0·130	−0·076	−0·16	0·13
Oscillation on the scale,	$Q_0 - Q_1$	100·2	97·5	276·8	280·2	277·3	296·0	252·1
Constants, -	W_g=2·745; W_p=0·4692; W_w=14·657							

In relation to the material employed in these experiments and the results obtained therewith, the following is to be remarked. The ruthenium was prepared from the perfectly osmium-free so-called iron residues of the mint of St. Petersburg. For this purpose the gray powder was taken, which

TABLE 7.

Elements.	Specific heat. *a*	Atomic weight. *b*	Atomic heat. *a*×*b*
Ruthenium, . . .	0·0611	52·0	3·18
Calcium, . . .	0·1722	20·0	3·44
" . . .	0·1686	20·0	3·37
Allotropic tin, . .	0·0545	58·8	3·21
Cast tin, . . .	0·0559	58·8	3·39
Indium, . . .	0·0574	37·8	2·17
"	0·0568	37·8	2·13

remains after the disintegration of this material with barium chloride in a stream of chlorine gas, and which gives by melting with potassic hydrate a copious yield of potassic ruthenate. The oxide thrown down from this salt by fractional precipitation with carbonic acid was converted into chloride with hydrochloric acid, the aqueous solution of this latter salt was precipitated with hydrogen gas, and the metal, in the state of lustrous scales, was ignited in a current of hydrogen to remove every trace of oxide. It proved on examination to be entirely free from the other platinum metals. The specific heat found therefor accords, as might be expected, with the previously accepted atomic weight.

The calcium was reduced by electrolysis from melted calcium chloride. It formed small pale golden-yellow globules with a high metallic luster, which take in the air, very rapidly, a grayish tarnish. Before enclosing in the glass envelope, they were shaved bright in an atmosphere of carbonic acid. Upon examination, it proved to be almost entirely pure. From the atomic heat thus found, it may be concluded that the previously accepted atomic weight $C_a=20$ is the correct one, and need not, as has become necessary with the atomic weights of the alkali metals, be halved.

Under allotropic tin is understood the singular modification of this metal, which appears to form from ordinary tin by long continued very low temperature. The specimen investigated came from the large mass, altered by the cold of an unusually long and severe winter, on which Fritzsche had observed this remarkable allotropy, first described by him. The mass consisted of an aggregate of small undeterminate angular rods loosely coherent in one direction, which crumbled by even slight pressure. This tin possesses, as I have convinced myself, a high degree of purity, contains no trace of antimony or arsenic, and dissolves completely in potassium trisulphid without leaving any basic metallic sulphids. The small rods of which it consists are not brittle but ductile like ordinary tin. The non-allotropic metal investigated was obtained by re-melting the

allotropic variety. Both modifications lead to nearly the same specific results.

The indium employed showed itself to be entirely free from tin, cadmium and iron. Oxidized by nitric acid and evaporated with sulphuric acid, it left upon solution in alcohol, no trace of plumbic sulphate. 1·0592 grams of the metal dissolved without loss in nitric acid, gave after evaporation and ignition 1·2825 grams indic oxide. If the latter, according to the previous views, be considered as consisting of equal atoms, there results from this determination the value for the atom of indium, In=37·92, which number agrees very closely with the one determined by Winkler, In=37·81. This atomic weight, multiplied into the obtained specific heat S_c, gives, however, for the atomic heat of indium the value, S_c In=2·13, which does not agree with the others.

The previously accepted hypothesis, that indic oxide is constituted according to the formula InO, appears therefore no longer tenable. If the atomic weight be accepted as once and a half so great, In=56·7, then will the atomic heat be, S_cIn= 3·23, nearly equal therefore to that of the other elements. The atomic weight 56·7 removes the anomaly, that indic oxide which was previously considered monacid, is, according to its entire deportment, analogous to that class of trin-acid bases, which forms no alums. For the previously accepted formulæ, given in column I of the following table 8, must therefore be substituted the ones in column II.

TABLE 8.

	I.	II.
Black indious oxide,	InO ?	InO ?
Yellow indic oxide,	InO	In_2O_3
Green indious-indic oxide,	$5InO, In_2O$	$2InO, In_2O_3$
Gray indous-indic oxide,	$4InO, In_2O$	$3InO, 2In_2O_3$
Hydrous indic oxide,	InO, HO	$In_2O_3, 3HO$
Indic sulphate,	$InO, SO_3, 3HO$	$In_2O_3, 3SO_3, 9HO$
Indic chloride,	InCl	$InCl_3$
Ammonium indic chloride,	$2NH_4Cl, 3InCl, 2HO$	$2NH_4Cl, In_2Cl_3, 2HO$

The ammonium-indic-chloride, prepared by R. G. Meyer, and cited in this scheme, possesses, according to the new formula, an analogous composition with ammonium rhodic chloride, which likewise contains 2 atoms of water. Whether or no the altered atomic weight finds comfirmation in an isomorphism in these salts I have been unable to investigate; I shall, however, return to this subject in a research, to be published later, on rubidium.

During this winter, for such experiments very unfavorable, I have been unable to make a trial of the instrument as to its fitness for the determination of the latent heats of melting. I

will only mention here that the latent heat of melting for water results already, with an accuracy which leaves nothing to be desired, from the experiments communicated in this work. According to table (2), one scale division of the calorimeter corresponds to $\frac{v\, s_e s_w}{s_w - s_e}$ grams of melted ice. The constant W_w, determined from equation (8), gives the number of scale divisions which correspond to one of the units of heat defined in the beginning of this treatise. One scale division of the colorimeter corresponds therefore to $\frac{1}{W_w}$ units of heat. If l denotes the latent heat of melting for water, then will $\frac{1}{l W_w}$ give the weight of ice, expressed in grams, which corresponds to one scale division. There results, therefore, for l, the equation $l = \frac{s_w - s_e}{W_w s_e s_w\, v}$ or, according to equation (2), $l = \frac{1}{W_w\, p}$.

If the above found values

$$p = 0{\cdot}00085257 \qquad W_w = 14{\cdot}660 \qquad W_w = 14{\cdot}654$$

be substituted in the equation, there is obtained for the latent heat of melting of water l: 80·01

80·04

In the mean, 80·025

The value found by other observers by the method of mixture is, according to Regnault, 79·4; Person, 80·0; Hess, 80·3.

The heat of combustion of gases may be determined by means of the ice calorimeter with far greater accuracy than has been possible with any of the methods previously at our disposal. From the heat of combustion of hydrogen it follows with the aid of equation (4), that 10 cubic centimeters of this gas at 0° C. and 0·76 mercury pressure, would produce by their combustion with oxygen an oscillation of 453 scale divisions on the instrument employed in the experiments just described. It is therefore sufficient to burn a very small quantity of gas, and therefore one easily to be prepared in a state of purity, in the calorimeter, and to observe the oscillation on the scale thereby produced, in order to obtain directly the heat of combustion, expressed in units of heat, without any of the corrections, in part very uncertain, which were previously unavoidable.

ART. LIV.—*On the Geology of the Delta, and the Mudlumps of the Passes of the Mississippi;* by EUG. W. HILGARD.

[Continued from page 246.]

II. *The Lower Delta and the Mudlumps.*

A glance at the map shows that in descending the Mississippi from New Orleans, we find a narrow strip of land only $\frac{3}{4}$ to 3 miles wide, dividing the river from the waters of the Gulf; from the head of Oyster Bay opposite Pointe à la Hache (about half way between the city and the head of the Passes), down to the mouths. Such, at least, is the case on the left bank; on the right, the "neck" begins a few miles below Fort Jackson. Down to the forts, the aspect of the "Coast" is generally pretty much the same, where its original character has not been lost by cultivation or encroachment of the river. Nearest the river, and highest above water level, are the sandy "willow battures," where the willow, mingled with and occasionally replaced by the cottonwood, forms the predominant growth. Beyond lies a belt of woodland, timbered chiefly with live-oak, magnolia, and cottonwood, often deeply veiled with long-moss; this belt embraces the richest and most durable soils of the "Lower Coast," and is mostly occupied by magnificent plantations of sugar cane and orange orchards. Beyond these, loom in the distance the sombre-hued, moss-curtained denizens of the cypress swamp, their tops forming a level platform sharply defined against the horizon. Between the swamp and the water's edge, seaward, there usually intervenes a zone of reeds, with here and there a stunted cypress, bay, or candleberry bush, where the salt water has but slight access.

While such is the general order of succession of these belts of vegetation where they coëxist, either or both of the two middle ones may locally be absent. Such is always the case where the "neck" is very narrow, as happens below the forts. Thence to the mouths of the passes, the willow batture and the reed marsh alone, with few exceptions, form the barrier between the river and the sea; it is traversed by numerous small bayous, some of which are in great part the work of the duck-hunters that supply the New Orleans market, and whose pursuit leads them to penetrate the marsh for the purpose of reaching the favorite resorts of their game. These bayous increase in frequency as we descend, and in approaching the mouths of the passes, the intervals between them become smaller, until they gradually become sheets of water dividing islands; and finally, just inside the bar, we have the latter resolved into numerous individual "mudlumps," dotting the surface of the sea, on both sides of the main channel.

Sir Charles Lyell remarks (Principles of Geology, 10th ed., p. 448), that the phenomenon of the mudlumps is without parallel, so far as known, in the delta of any other river. The same remark might, I think, appply to two other peculiarities, viz: the protrusion of the long neck of land into the Gulf; and the fact that, after failing to send out any branch of importance for a hundred miles, the great river suddenly divides at one point into three widely divergent branches, the middle one of which (the South Pass), forming the direct continuation of the channel, is the smallest, and has long ceased to be navigable. Evidently, a strong extraneous obstacle alone could turn aside the powerful current, and permanently resist its erosive and undermining action. And now, the channel which carries the main current (the Southwest Pass), faithful to the old tradition, is rapidly pushing out into the Gulf its narrow bands of reedy marsh, without a branch of any consequence in ten miles from the head of the Passes to the light-house.

A glance at the coast lines, as well as at the intricate ramifications characterizing the deltas of the Rhine, the Po, the Danube, the Ganges, or the Hoang-Ho; or the broad inlets forming the mouths of the rivers of South America, will show the uniqueness of the Mississippi mouths; the Nile and the Lena alone exhibiting a general form at all analogous, yet very distinct in detail. For the islands off the Lena mouths are not "mudlumps;" and the tongue of land separating Lake Menzaleh from the Damietta branch of the Nile, is a mere sand-bar, exhibiting no analogy save that of form, with the remarkable "necks" of the Mississippi Passes.

It would be fair to infer, à priori, that some connection exists between the exceptional phenomenon of the mudlumps, and the exceptional form of the delta; and that such is really the case, can hardly be doubted upon a candid investigation of the facts. So far from being an unusual phenomenon, *the mudlump-formation appears to constitute the normal mode of progression of the Mississippi mouths;* not only at the present time, but for many ages past; perhaps ever since the broad flood of the Terrace epoch subsided into the present Mississippi.

The characteristic features of the mudlumps have successively been described and discussed by Sidell,* Forshey,† Chase, Beauregard and Latimer,‡ Thomassy§ and Lyell.‖ Yet as the phenomena are nowhere described in their entirety, I will here, as briefly as possible, recapitulate the important points.

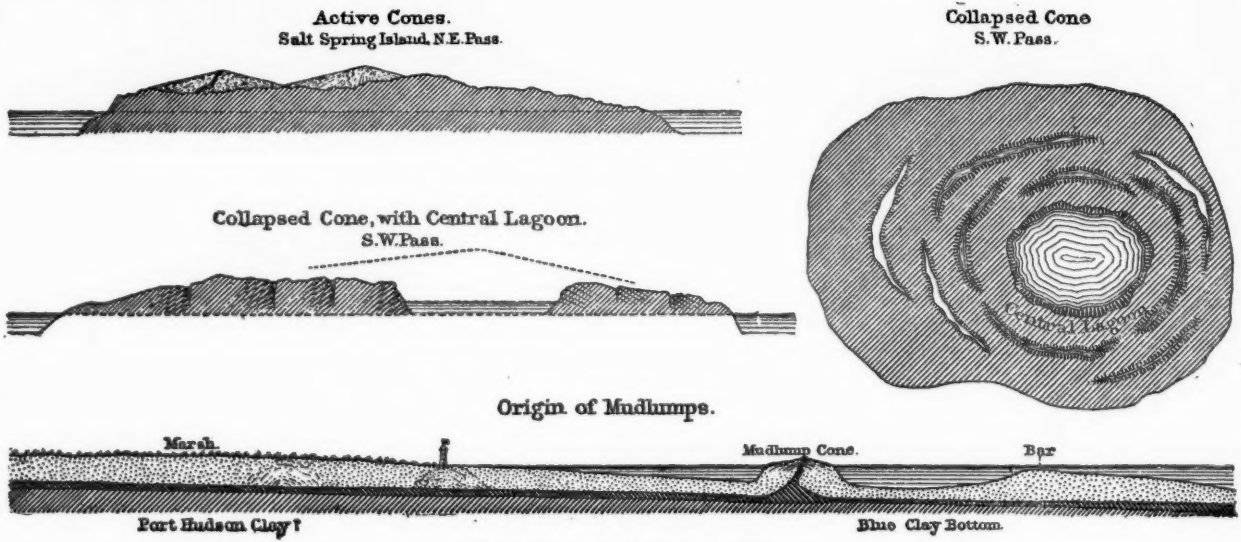
* Report to Capt. Talcott, 1839, in Humphreys and Abbott's Report, App. A.

† MS. Report, 1850.

‡ Report of the Board of Engineers for the Examination of the Mississippi; Congress. Doc. 1852–53.

§ Geologie Pratique de la Louisiane, 1860, Chap. VI.

‖ Principles of Geology, 10th edition, 1868; vol. 1, p. 449.



MUDLUMPS OF THE MISSISSIPPI DELTA.

The mudlumps originate in upheavals of the bottom, in the region lying between the extreme point of the mainland and the crest of the bar, at the main outlets of the passes. They all lie within a distance of from one to three miles from the axis of the main current, and nowhere extend into the bays intervening between the several active mouths. The pilots are under the impression that they form more frequently in the main channel than elsewhere; but allowance must be made for the natural infrequency of their observations outside of the latter; so that only the more obvious and remarkable changes of the bottom, when occurring outside of their regular range, would be likely to come under their notice. *A priori*, it would seem probable that inasmuch as the resistance to the upheaving force, other things being equal, must be less in deep than in shallow water, the lumps would rise more frequently and more rapidly in the channel than elsewhere. On the other hand, the denuding force of the river current must greatly diminish the chances of any such upheaved mass appearing above the surface, or even becoming manifest by a diminution of depth, when progressing slowly. Weighing these considerations against each other, I think a balance remains in favor of the pilot's opinion: the more as concurrent testimony goes to show that whenever the channel is changed, either by the accumulation of deposit or the interference of a mudlump upheaval, the old channel is promptly occupied by mudlumps *throughout* the abandoned portion.

As regards the rapidity of the upheaval, it appears to vary from an almost secular rate, to that of several feet in 24 hours. It has been rumored that lumps had been seen to rise visibly, and burst open like a bubble, but I have been unable to trace the statement to any reliable source, and it is discredited by the pilots. The most rapid rise of which I have obtained reliable information was witnessed by Capt. Andrews, of New Orleans. He states that a steamer having run aground about nightfall inside the bar, her bow being on a mudlump in about 2½ feet of water, he towed her off during the night, and in the morning found the imprint of her bow 18 to 24 inches above water, in the soft mud. Allowing for the possible maximum influence of tides in favor of the difference observed, the minimum rate of upheaval, according to these data, still amounts to one inch per hour. Nor is this the only case in which a rapid shallowing of the water has been observed as a consequence of the grounding of large vessels. This has usually been ascribed to the accumulation of deposit in the slack water so formed, and in many instances this may have been the true cause. But this explanation can hardly apply to the case detailed above, and it is reasonable to suppose that the shock of a grounding vessel may

in many cases prove "the hair that breaks the camel's back," when acting upon a portion of bottom just about to yield to the upheaving force, and therefore in a state of unstable equilibrium. Future observations, however, will readily settle the question.

Of authentic observations illustrating ordinary rates of rising, I quote the following remarks of Mr. H. L. Marindin, U. S. Coast Survey, who in 1867, while engaged in the survey of the mouths, at my request paid considerable attention to the phenomena of the mudlumps, and made an interesting report to me on the subject, dated June 20th, and accompanied by specimens.

"Since the first examination of the mudlumps on Southwest Pass Bar, there have appeared numerous lumps in the vicinity of the main channel, whose appearance cannot be attributed to other causes than the upheaval of the bottom by some unknown agency; since tidal observations made during the month of April, May and part of June, show no material decrease in the height of water in the river, other than the daily ebb of the tide. In one instance, also, on this bar, it has been ascertained from surveys made at different times, that where in the month of April a channel with fifteen feet of water existed, there is now a lump, doubtless still forming, with only six feet of water on it at the highest stage."

Making allowance for a possible accumulation of deposit, the rate of rise cannot, in this instance, be estimated at less than two feet per month; which, so long as the lump remains under water, seems to be no unusual amount. When, however, the surface of the water is once reached, the rising becomes slower or ceases altogether, owing probably to the greater weight acquired by the material upon its emergence. At least, I have failed to find much above tide level, any material which did not bear distinct evidence of its having been formed, not by river alluvion, but by the action of the regular mudsprings; which, if not now active upon all the lumps, have demonstrably been instrumental in forming the great majority of the masses now above water level.

I do not know that any one has ever witnessed the first outburst of a mudspring on a newly risen lump; but we find them in all stages of progress, from the islet bearing its first tuft of rushes, to the active cones glistening in the sunshine, and from time to time, when an unusually large gas bubble rises, spattering the liquid mud (which usually flows in a quiet stream) all over the slopes; then the half-extinct cone, in whose crater a little pool of salt water is at long intervals agitated by a gas bubble; then the extinct and collapsed cone, surrounded by a circular moat and Somma-like ring-wall; next, the old lump of

jagged outlines, whose disintegrated materials are rapidly yielding to the combined attack of rain, sunshine and waves, till something looking like a large stump of a tree is all that remains of an island of several acres; and finally the shoal, marked by dangerous rollers, whose surface, on a calm day, still exhibits the concentric markings corresponding to the several cones which originally built up the island.

I regret being unable at the present time, to present accurate sketches of these several stages of "the mudlumps' progress." I hope to do so hereafter, but for the present must confine myself to the approximate outline representations given in the plate, and a brief description of the several stages as observed by myself in 1857.

Nascent Lumps.—As regards the first, it is probable that a good many lumps never pass beyond that stage of development, for the reason that, so soon as the resistance is materially increased by the emergence of a portion above the surface of the water, the upheaving force seeks a vent elsewhere.

Either the mud or gas-spring breaks out beneath the water, and becomes perceptible only by the more or less regular and localized evolution of bubbles on the outskirts of the lumps; a very common phenomenon in the neighborhood, not only of new and active lumps, but also about extinct ones, which are in course of demolition by the waves. On the extensive sandy shoal off Stake Island, on the Southwest Pass, such subaqueous gas-springs may be observed in great numbers.—Or it may happen, that another portion of the bottom, now offering less resistance than the mudlump, will, in its turn, give way before the upheaving force, till the same degree of emersion is obtained, or a vent is opened.

I have been unable to ascertain how high any mudlumps can rise bodily above the water without the appearance of a vent. As much as three feet has been observed with certainty; but unless the fact that it is a new upheaval be historically known, it must be extremely difficult to ascertain it, unless, by actual access to the interior, it can be shown that its surface strata are old river deposits, which can readily be distinguished from those formed by mudlump vents. Yet these might, during the elevation of the lump, have been removed by the current. At all events, I have failed to find on the surface of any lump much above tide-water, anything like true river alluvium; the visible material being either such as is now formed by active vents, or, (as on the lower slopes), that which obviously results from the disintegration of the former, being altogether devoid of structure.

It is said that lumps sometimes sink from view again after bare emergence. I know of no authentic example, but it

seems likely enough that upon the formation of a large vent elsewhere, such a thing might happen; especially if, as I think probable, mudsprings and mud-cones form *beneath*, as well as above the water.

Active Cones.—In the second stage, that characterized by the formation of the active eruptive cones, mudlumps offer an aspect so strikingly like that of the mud volcanoes of Tuscany, as to stagger the observer's geographical consciousness. The most striking example of the kind existed, at the time of my visit, off Pass à l'Outre, on the south (right) side of the channel. The island* is about an acre in extent, and besides the active vents (of which there are seven), we perceive on the southern portion the remnants of long extinct craters, in various degrees of advancement toward old age and degradation, and partially covered with vegetation.

The cones on the north or channel side, at a distance, present a glistening surface, and those possessing a central vent only are very regularly and smoothly conical. Of these there are four, the diameters of the bases ranging from eighteen to fifty feet, and their elevation from one to two and a half feet above the general level of the island; making the angle of the slope from 5° to 8° only, instead of 25° to 35°, as given in the published sketches. I have seen no undisturbed cone whose slope exceeded about 12°. The slope is, of course, essentially a function of the thickness and character of the mud; which in the present instance flows from the circular basin at the summit, 4 to 8 ins. in diameter, in a regular, creamy stream, interrupted occasionally only by a gas bubble; which, if the mud be thick, spatters it about to some extent. The mud-stream varies from 3 to 4 gallons per minute in the largest (eastern) cone, to a pint or two in the less active ones; sometimes, in running down the sides, it spreads over as much as $\frac{1}{8}$ of the circumference, but usually forms a stream 4 to 8 inches wide, serpenting down the slope between banks formed by its own solidification, as does a lava stream. As these banks grow in height by drying, on the edge of the crater, they gradually compel the mud to rise higher before it can flow off; whereupon, after a while the column overflows at another point of the circumference, where the same play is then repeated. In the meantime, the previous mudstream has an opportunity of consolidating, drying more or less, and undergoing a variety of chemical changes dependent upon the character of the water and the duration of the exposure to the air, which manifest themselves in changes of color and consistency; by these the individual streams are distinctly defined from one another. Each one forms, of course,

* It was named Marindin's Lump by the crew of the U. S. Coast Survey Schr. Varina, and I shall allude to it under that designation.

a more or less irregular portion of a conic surface, the cross section being more or less lenticular.

There results, as may be supposed, a very peculiar structure or stratification, unlike anything usually seen outside of volcanic districts, unless, perhaps in the somewhat analogous case of the lee side of dunes. It may roughly be compared to the upper half of an onion. It is needless to say that, once seen, it cannot readily be mistaken for anything else; and its absence must be held as proof conclusive of an absence of genetic analogy.* The thickness of the layers rarely exceeds $1\frac{1}{2}$ inches; their colors vary from dark mouse-color and bluish gray, through dun and buff, to rust-color and red; the materials, from hard, plastic clay, always containing a great deal of fine silex and more or less coarse sand, to sandy clay and, rarely, clayey sand; the selvedges are frequently marked by iron rust and mica scales. Where, as is frequently the case, neighboring cones are confluent at their bases, the structure is of course complicated in a manner readily imagined.

As regards the gas evolved (which is in all cases inflammable), the small proportion its bulk bears to that of the mud simultaneously ejected (about $\frac{1}{2}\frac{1}{5}$ to $\frac{1}{3}\frac{1}{6}$ at Marindin's Lump), at once does away with the impression mostly entertained, that the gas bubbles bring up the mud with them. The latter comes up with a steady flow, evidently the result of static pressure, and is only from time to time agitated by a gas bubble, larger or smaller according as the mud is more or less consistent. We sometimes find, about extinct cones especially, lively gas springs in which the proportion of gas is considerably greater, than happens in any active cone that has come under my observation; but in that case, it is almost always accompanied only by *water*, as though its source were above the stratum which furnishes the mud. For, a glance at the river deposits forming around the lumps, at once shows that they are totally different from the fine, clayey material of which the cones are formed; nor is it credible that the mere passage of a current of water and gas through such deposits, or in fact, *any consolidated materials*, should produce such a perfect, creamy mixture as that ejected from these craters.

Extinct Cones.—Good examples of cones whose activity has nearly or quite ceased, may be seen off the Northeast Pass. Here the material is somewhat sandier and firmer than the mud ejected at Passe à l'Outre. While at the latter place it was difficult to reach the craters without being hopelessly

* Vide Thomassy's remarks on the Five Islands, etc., Géol. prat. de la Louisiane, chap. viii. With even less show of reason, a similar origin has repeatedly been claimed for the low circular mounds which dot a large part of western Louisiana. They consist exclusively of unstratified sandy materials, and are doubtless the result of animal activity—probably of the large ant.

bogged, they can readily be reached almost dry shod at the Northeast Pass. Here, also, the top layers were peeling off in large concave "flakes," from the effect of sun-cracks and drying; such a surface again overflowed by mud would add another singular feature to the structure of the cones, which may also be noticed in many sections of ancient ones.

The vent of a large cone in this region (see Plate) formed a basin about 8 inches diameter, containing a puddle of salt water covered with an iridescent ferruginous pellicle, disturbed at long intervals by small gas bubbles. Evidently, the resistance in the large cone, elevated about 10 feet above the water level, had become too great for the ejection of mud; in consequence whereof, a lively little cone was glistening and bubbling at a level several feet lower, near the foot of the old cone. *But the testimony of the pilots goes distinctly to show, that the active cones become more lively, and dormant cones resume their activity, at high stages of water in the river.* At the time of my visit, the water was at an unusually low stage.

Collapsed Cones.—The cones, especially the larger ones, appear to be unable to survive for any great length of time the cessation of activity. The change that occurs seems to be, in all cases, a sinking of the central portion, often to such an extent that its place becomes occupied by a pool or lagoon, surrounded by a circular rim whose strata incline *away* from the center at angles invariably much steeper than is found in any recent cones, from 20° to as much as 45°. Outside of this first rim there mostly appears a series of concentric crevasses, sometimes several feet in width and in depth; and the annular segments thus brought to a level by a subsidence, also exhibit the singular feature of a *steeper* inclination of the lines of deposition, than is found in any cones now forming. The seeming anomaly of this fact caused me to observe the phenomena closely; but I have been unable to find an exception to the rule; and I have been led to doubt whether in some cases, instead of true eruption cones, these collapsed areas and their surroundings may not be the remnants of the original upheaved "bubble." The objection to this interpretation is the character of the material, which, excepting in a few cases on the Southwest Pass, is altogether unlike the present river deposits, both in structure and composition.

A most perfect exemplification of a large central lagoon (100 feet by 75) surrounded by an elevated rim and several successive, concentric "moats," also in part filled with water, occurs on one of the numerous mudlumps S.W. of Stake Island, on the Southwest Pass (see Plate). The central portion does not always, however, sink out of sight; sometimes a conical mound is still observable, as the center of the more or less circular,

concentric crevasses, which a close inspection shows to exist on almost all lumps not too far advanced towards decrepitude. Many islands exhibit several such centers and systems of crevasses, indicating, probably, the previous existence of cones, sometimes several hundred feet in diameter, greatly exceeding the largest now in a state of activity, both in diameter and original height.

Degradation and Disappearance of Lumps.—The direct action of the waves, unassisted by atmospheric agencies, produces but little effect upon the yielding, but tough and coherent material of the cones. The heaviest breakers and rollers spend their force in vain against the clay shoals which render most of the lumps so difficult of access. The unwary will often be tempted by the deceptive, rock-like aspect of this material, to jump into the shallow water and wade ashore; but a plunge knee-deep into the apparent solid will frequently reward his temerity. Yet so long as this mass, which shows plainly the peculiar, concentrically banded mudlump structure, remains constantly covered with water, the waves rolling over it produce but little impression.

Not so with the portion that projects above water, which is alternately exposed to rain, sunshine, and the wash of waves. Especially where the material is clayey, these agencies combined soon produce a change in which the structural as well as the paleontological characters of the original material are totally obliterated. A rain falling upon a fresh surface of the latter, causes it to swell; then, upon exposure to sunshine, it will contract into prismatic cleavage-forms. A slight rain, or the spray itself, will then cause the extreme surface to crumble into, and partially fill up, the cracks; when the swelling consequent upon a thorough wetting, by either rain or waves, will force them to open still more, while streamlets of fluid mud follow each retiring wave; which, perhaps, has thrown up, and left high and dry in the cracks, a dozen species of shells, entirely foreign to the mudlump mud itself. It is thus that the structureless, tough soil of the general surface, and of the beach of the mudlumps, is formed; and to it alone apply the descriptions given of the mass of the mudlumps, by Sidell, Thomassy and Lyell, as a "homogeneous, tenacious mud."

A frequent repetition of this process involves, of course, not only a rapid direct degradation of the lump, but it causes it to be cleft into fragments by rents gradually progressing from above downward, which rapidly increase the surface exposed to attack; and eventually, some large wave, in retiring, carries down with it a huge prismatic slice, leaving behind an almost vertical cliff. This is carried away in its turn, and thus, attacked from all sides, an island of considerable size, after

passing through a variety of middle stages in which it strikingly resembles masses of trap or basalt, magnified into distant mountains by the peculiar optical delusion prevailing in the region,* is finally reduced to what, at a distance, appears to be the stump of a tree. At last, some storm sweeps away this last monument of the disappearing lump, and white-capped rollers alone mark, thereafter, the higher points of the mud-shoal.

I have best observed these phenomena of disintegration in every stage of progress, among the mudlumps off the Northeast Pass, where the fanciful, cliff-like forms, figured by Thomassy, Sidell, and Lyell, may be seen to perfection.

It is said that there are no mudlumps off South Pass or Grand Bayou; a statement which may require to be taken with a grain of allowance, but agrees with the general impression that the mouths discharging the largest amount of water, also exhibit mudlump activity on the most extensive scale.

The Southwest Pass is the main outlet at the present time; the area inside the bar is thickly studded with mudlumps, chiefly west of the channel; and as before stated, lumps have risen there repeatedly under the eyes of the pilots and survey parties. Yet there is not there, at the present time, a single *active* cone, so far as I am aware; although salt water and gas springs are of frequent occurrence, both on and around the islands. There is a marked difference between the river deposits as well as the mudlump materials of Passe à l'Outre and Southwest Pass, the latter being decidedly more sandy, and sand bars taking the place of the mud flats off the former. Whether this circumstance (the natural result of the greater swiftness of the current in Southwest Pass), is connected with the absence of active cones, it may be too early to discuss. Some very lively springs on a large mudlump off Stake Island on that Pass, in which the gas emitted is about equal in bulk to the water, rise in small basins excavated at the foot of a large cone which must have been 15 to 18 ft. high; but the material they bring up is so very sandy that the water runs off perfectly clear.†

Mudlumps in the Marshes.—I have before remarked, that at the present time, the upheaval of mudlumps on the passes, and subsequent silting up of the shallows between them (by river deposit, as well as by the degradation of the lumps themselves,) seems to be the normal mode of progression of the delta. The more advanced portions of the narrow bands of shore now

* Caused probably by a faint bluish haze, through which an island a quarter of a mile distant and 15 feet high, appears to be a wooded mountain with rocky escarpments, and at its foot a wide spreading city—which suddenly resolves itself into a row of grave white pelicans perched on the beach and taking wing at the approach of a boat.

† See analysis of the water of these springs, below; marked "S. W. Pass, I."

forming along each one of the passes, are historically known to consist of mudlump-chains; and in the absence of any plausible presumption to the contrary, as well as of any parallel example in other rivers, it is reasonable to surmise, that not only the shores of the present passes, but also the neck, *at least* from Pointe à la Hache down, owes it formation and peculiar features to the same agencies.

We have seen how rapidly and completely the joint action of the waves and atmospheric agencies accomplish the degradation of elevated lumps to the common level of the tide; and where the nature of the materials is such as to yield readily to these destructive influences, it would be unreasonable to look for vestiges of ancient lumps above that level. Such is the case, as before mentioned, on Northeast Pass and its branches.* But the sandier nature of the mudlump mass on Southwest Pass enables it to resist much longer, so that some of the larger and more elevated islands there seem destined to retain, more or less permanently, their present form. For the same reason, perhaps, the Southwest Pass furnishes the one prominent example of the existence of an active and characteristic mudlump, in the level marsh on the right of the channel, about five miles below the Head of the Passes, and seven above the mouth (light-house); distant 1½ miles from the river bank, and about one mile from the beach of West Bay. Double-headed Bayou, or one of its channels, passes within a few hundred yards of this lump; which is so difficult of access that it has been very rarely visited, though plainly visible from the hurricane deck of passing steamers, from which I have examined it with the telescope.

According to Thomassy,† the pilot Ben. Morgan, who has visited it, describes it as being "a regular truncated cone, 20 to 25 feet high and 300 in circumference, spouting at intervals from its summit masses of clayey and sandy mud, which overflows all around."

From the Pass, it now appears as a slightly irregular, conical hill, which, judging from the extent to which it projects above the highest reeds, is about 18 to 20 feet high at most. On its eastern side there is a second cone about half as high, with a very regular slope not exceeding 30°, while that of the large one is at least 45°. A whitish sheen which extends from the summit of the larger cone toward the smaller one, I interpret as a white salty efflorescence; but on the south slope of the smaller

* Col. Sidell mentions a mudlump cone, 18 feet high, on the north side of the Northeast Pass, in the marsh. It has probably succumbed since his visit, as in passing the spot I was unable to perceive any elevation, nor was it known to the pilots.

† Géol. prat. de la Louisiane, p. 56. I shall designate this cone as "Morgan's Lump."

cone, the glittering of a flowing mudstream was unmistakable. Inasmuch as in Morgan's account of his visit the smaller cone is not mentioned, it is presumable that it has been formed since, by a lateral eruption; the old cone having, perhaps, reached the extreme limit of height to which mudlump force can raise its materials.

The steep slopes of both the old and new cone are suggestive as to the influence of sandiness on that feature, and the explanation of the steep inclination of strata, observed chiefly on Southwest Pass.

It is my impression that another cone exists in the marsh about two miles south of these. It is almost screened from view by the reeds, but the telescope shows it to be distinctly conical. It does not seem to have attracted notice heretofore.

But if mudlump cones are scarce in the marshes, the same is not true with reference to the salt and gas springs, which are reported to be quite abundant by the hunters—the only men whose occupation leads them to "thread the pathless waste" of reedy marsh, otherwise seldom visited, save by surveying parties, and alligators. These springs are found on or around all mudlumps, of whatever age; even on the shoals left behind by disintegrated lumps, where they issue under water, sometimes altering perceptibly the character of the water in the immediate neighborhood. The Southwest lighthouse was originally built on a mudlump separated from the mainland by a bayou; this is now filled up, but salt springs still issue at several points in the marsh near the foot of the tower. It is obvious that the gradual accumulation of deposit is not likely to check lively springs, possessing sufficient head to rise, hydrostatically, above the level of the alluvium; though in many cases they may lose themselves in the sandy strata.

I have not had an opportunity of ascertaining whether or not salt springs are known to exist in the marshes near the Forts, and above. I fully expect to find, however, that they do exist, though, for obvious reasons, they will become less and less abundant as we ascend the river. At New Orleans, as already stated, gas and salt water are reached, and brought to the surface with considerable vehemence, by bores varying from 31 to 56 feet;* and I have no difficulty in believing in the correctness of the impression made upon Col. Sidell, that the foundations of the New Orleans customhouse were located upon a mudlump.† That such obstinate resistance as that of the "Head of the Passes" to denudation can hardly be attributed to a mass of river deposit, I have already intimated. A large mudlump mass has, probably, first caused the deflection.

[To be continued.]

* See above, p. 245.

† Lyell's Principles of Geol., 10th ed., p. 552.

ART. LV.—*On the existence of the (so-called) compound Ammonium Amalgams;* by the late CHARLES M. WETHERILL, PH.D., M.D.

THE discoverer of methylamine did not succeed in forming a compound analogous to the ammonium amalgam, whether by the reaction of methyl ammonium chlorid with potassium amalgam, or by the influence of the galvanic current. This experiment, with negative results of Wurtz, is quoted in nearly all of the descriptions of the compound ammoniums.

In a series of experiments (this Journal, II, vol. xl, Sept., 1865) upon the formation and nature of the ammonium amalgam, by which it was demonstrated that this body is merely a metallic froth, I succeeded in forming the so-called amalgam of methyl ammonium. This body was found to be of a nature essentially similar to that of the ammonium amalgam, but of less turgescence. The salt used was the methyl ammonium oxalate, which was compared in this reaction with the ammonium oxalate. MM. Pfeil and Leffman (this Journal, II, vol. xlii, p. 72) repeated these experiments and confirmed the results, employing the tri-methyl ammonium chlorid. They also extended the reaction with sodium amalgam to the chlorohydrates of aniline, coniine, morphine and quinine and to the acetate of rosaniline; but without forming amalgams, hydrogen gas being evolved copiously without swelling.

H. Landolt (VI supplement, Annalen der Ch. u. Pharm., p. 346, "Ueber das ammonium amalgam") states in a foot-note, that he had repeated the experiment with tri-methylamine chlorid and sodium amalgam, and found "that the turgescence of the mercury takes place only when the preparation contains ammonium chlorid; the pure compound gives no amalgam.

This rendered necessary a repetition of my experiment upon the compound ammonium amalgam, as I had not myself tested the salts employed with respect to their purity. The former experiments were performed with a pure methyl ammonium oxalate, for which I am indebted to the kindness of M. Carey Lea, Esq., who gave me some prepared by his new method, being the same described by him in this Journal, vol. xxxiii, p. 366.

In the present experiments I prepared a fresh portion of the methyl ammonium oxalate by Lea's process, viz: by the action of aqua ammonia upon methyl nitrate. The two liquids were placed aside in a stoppered bottle for ten days, by which time the ether had disappeared. The distillate of this liquid over caustic potassa was exactly neutralized by oxalic acid and evaporated to crystallization. After removing the ammonium

oxalate. the mother water was evaporated to dryness and boiled with 95 per cent alcohol; the hot filtrate on cooling yielded nacreous scales of methyl ammonium oxalate. The mother water of these crystals, by concentration, furnished an additional quantity a little darker in color. By filtering the crystals and washing them with 95 per cent alcohol by the aid of the Bunsen filter pump, they were completely freed from the dark mother water in which they formed. As the quantity of salt at my disposal was not more than a gram, fearing to reduce it by a recrystallization, I first tested the effect of a solution of the crystals upon sodium amalgam, and then converted a portion of each cup to methyl ammonium oxalate in which the Pt was determined. All which remained of the oxalate was recrystallized from a hot solution of alcohol and ether and experimented with, as in the former case. The crystals appeared to the naked eye to be prisms, but the microscope demonstrated them to be feathery needles polarizing light. They were very electric when warm, and possessed the property of felting together when pressed by the finger. They yielded golden-yellow crystalline scales or plates when converted into the Pt salt This salt is much more soluble than the corresponding ammonium salt, and crystallizes again from its solution in golden yellow hexagonal and triangular scales, being part of the octahedron and its replacements. The following are the results of the different analyses, from which it may be perceived that the methyl ammonium oxalate is perfectly pure, and that, as stated by M. Carey Lea, the first crystallization of the oxalate is pure.

I noted with respect to the Pt salt that some crystallizations furnished scales of a reddish tinge, but which gave the same percentage of platinum as the golden-yellow scales. The small quantity of substance at disposal for the analysis required very careful weighing to $\frac{1}{4}$ of a milligram.

Analysis of methylam. chloroplatinates from methylam. oxalates.

	Grms. taken.	Grms. Pt.	Per cent Pt.*
First cryst: darker oxalate,	0·4155	0·172	41·40
Repeat,	0·43975	0·18325	41·67
First cryst: lighter oxalate,	0·345	0·1435	41·59
Ditto recrystallized,	0·13675	0·05675	41·50
Chloroplatinate from mother-water of the last chloroplatinate,	0·0655	0·027	41·30
Mean of all the analyses,			41·49
Wurtz's analysis,			41·40
Theoretical per cent,			41·59
Ditto for ammonium salt,			44·29

These different specimens of methyl ammonium oxalate, dissolved in water, gave similar results when shaken with sodium

* Eq. Pt 1·98.

amalgam. To ascertain this fact, a portion of fluid sodium amalgam of the size of a pea was placed in a small test tube ($\frac{1}{4}$ inch diam.), and the solution of ammonium oxalate added, the swelling was observed both with and without shaking, in the cold and with warming. The same experiment was performed with the different specimens of methyl ammonium oxalate. The latter all swelled to from 8 to 10 times the original volume, which was very much less than the turgescence of the ammonium salt. With the compound ammonium salt, the swelling was not apparent until the tube was shaken and heat facilitated the reaction; this may be the reason that it has been hitherto overlooked. The methyl ammonium amalgam presented the same buttery appearance as the ammonium amalgam, and a knife blade placed in it was amalgamated. When the lump was pressed between two plates of glass, as in the method I proposed, to prove the frothy nature of the so-called ammonium amalgam, myriads of gas bubbles were apparent; when these were pressed out the amalgam was at once restored to the condition of mercury. In all cases shaking the tube appeared to be necessary in order to develop the swelling to its *fullest* extent. In performing this act, care was taken not to convey the ammonium salt to the methyl ammonium tube by the finger.

In the former experiments it was not deemed necessary to form the compound ammonium amalgam by the aid of the battery; in the present this result was attained in the following manner, (vide op. cit., Exp. 15).

A piece of filter paper was placed upon a glass plate, then saturated with a strong solution of the recrystallized methyl ammonium oxalate. A globule of mercury of the size of a small pea was placed upon the paper with the negative pole of 20 cells Bunsen in contact with it; the positive pole touching the paper. The globule swelled slightly, presented a buttery appearance, attached itself to and amalgamated the blade of a penknife which was in contact with the negative pole, and upon being pressed under a glass plate *showed innumerable gas bubbles in its substance*, (in fact was a metallic froth) which emitted an ammoniacal odor.

It results from these experiments that the compound ammonias (at least that which I have examined) may form the so-called amalgam. I defer the bearing which this fact has upon the so-called ammonium and hydrogenium amalgam to a paper of some experiments which will shortly be published.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the spectrum of the Aurora Borealis.*—Zöllner has called attention to the fact already remarked by other observers that the lines in the spectrum of the aurora borealis do not coincide with those of any known element, and has endeavored to give a rational explanation of the want of coincidence without assuming the presence of unknown elements in the earth's atmosphere. If the lines in question are really of electrical nature and are produced by the ignition of highly rarefied gases, the ignition must take place at so low a temperature that it would be impossible to observe the lines in Geissler's tubes. Hence Zöllner thinks that the spectrum of the aurora does not correspond with any known spectrum of the atmospheric gases, because it is a spectrum of a different order which cannot at present be produced artificially. If, at a given temperature, $A\lambda$ and $E\lambda$ represent respectively the values of the absorptive and emissive powers for the wave length λ for the unit of thickness and density, m and σ the thickness and density of the luminous layer of gas, we have, according to Zöllner, for the brightness E of the part of the spectrum corresponding to λ, the expression

$$E=[1-(1-A\lambda)^{m\sigma}]\frac{E\lambda}{A\lambda}.$$

For a given gas and given temperature this expression depends only on the value of the product $m\sigma$. In a Geissler's tube filled with rarefied air, take the diameter of the narrow part of the tube as 1^{mm}, and regard this as the unit of thickness m, and take as the unit of density the density of the enclosed air corresponding to a temperature of 0° and pressure of 1^{mm} of mercury. If now we ignite the air in the tube by an inductorium, then at a constant temperature the spectrum would remain qualitatively and quantitatively unchanged if the diameter of the narrow tube were increased from 1^{mm} to 1000^{mm}, and if at the same time the pressure on the gas were diminished to $\frac{1}{1000}{}^{mm}$.

Wüllner found that in the case of nitrogen the spectrum became sufficiently luminous for spectroscopic examination only when the pressure was diminished to 46^{mm}, while in the case of oxygen the necessary diminution was to 28 to 30^{mm}. If we assume that in Wüllner's apparatus the current passing through a tube 1^{mm} in thickness and under a pressure of 50^{mm} produces light enough to observe the atmospheric spectrum, we may compare with this the thicknesses of the luminous layers which occur in the case of the aurora, which are of course far greater, and, at a distance from the zenith, to be estimated in miles. If we take the thickness of such a layer as only 1 kilometer, then at the same temperature as in the last case, the density would have to be only the one-millionth of that of the air enclosed in the tube, and therefore exert a pressure of only $0{\cdot}00005^{mm}$ at 0° C., in order that the

spectrum of the air in the tube should completely correspond with that of the aurora. The question then arises—is it permissible to assume the existence of such low degrees of pressure in the regions of our atmosphere in which the aurora is developed? If we suppose the aurora to be at a height of ten geographical miles, the temperature of the atmosphere at the surface of the earth being 0° and the barometric pressure 760^{mm}, the pressure will be $0{\cdot}078^{mm}$; at a height of twenty miles, $0{\cdot}00001^{mm}$. A layer of ignited air 1^{m} in thickness would therefore, at a height of ten miles, be equivalent to a pressure of 78^{mm}, and at a height of twenty miles, to a pressure of $0{\cdot}01^{mm}$ in a Geissler's tube, in order at the same temperature to give a spectrum as bright as that of the aurora. But as the thickness of the layer of ignited air must be reckoned by kilometers instead of meters, we should have, even at a height of ten miles, so high a value for the equivalent pressure in a Geissler's tube—78^{m} of mercury for a layer 1 kilometer in thickness—that the most powerful induction apparatus could not overcome the resistance of the air. From this it follows that the quantity of particles of ignited air in a Geissler's tube is probably extremely small when compared with the *active* quantity in the case of the aurora. Since, however, the spectrum of a gas in such a tube must have at least the brightness of the auroral spectrum to admit of spectroscopic analysis, it follows that the emissive power of the particles of gas ignited in the tube must be much greater than that of the ignited gaseous particles in the case of the aurora. Such a difference can be produced *only* by differences in temperature. If, therefore, the light of the aurora depends on ignited particles of our atmosphere, the temperature at which the ignition takes place must be much lower than that at which the same gases can be ignited by electricity in Geissler's tubes. From these considerations it appears that all the gas-spectra of the different orders which we can artificially produce belong in general only to high temperatures, since the relatively greater brightness with less quantities of ignited matter renders a greater emissive power necessary, and this can be produced only by a higher temperature. Conversely as in the case of the aurora, corona, zodiacal light, &c., a great number of active luminous particles must be assumed to exist, it follows that the temperature of the ignited gases must be relatively low.—*Pogg. Ann.*, cxli, 574. W. G.

2. *Synthesis of coniin.*—By the action of an alcoholic solution of ammonia upon butyric aldehyd, at a temperature not exceeding 100° C., SCHIFF obtained two bases, the formation of which may be represented by the following equation:

$$\underset{\text{Tetrabutyraldin.}}{C_{16}H_{29}N\Theta} = 4C_4H_8\Theta + NH_3 - 3\Theta H_2$$

$$\underset{\text{Dibutyraldin.}}{C_8H_{17}N\Theta} = 2C_4H_8\Theta + NH_3 - \Theta H_2$$

By the distillation of dibutyraldin, besides oily substances and bases of a higher order of condensation, a strong alkaline base is

obtained which possesses all the properties of coniin, the formation of which may be represented by the equation:

$$\underset{\text{Dibutyraldin.}}{C_8H_{17}NO} = OH_2 + \underset{\text{Coniin.}}{C_8H_{15}N}$$

According to this synthesis, the structural formula of coniin would be:

$$\begin{array}{l} CH-CH_2-CH_2-CH_3 \\ \quad\vdots \\ CH-CH_2-CH_2-CH=NH \end{array}$$

The author promises further details.—*Berichte der Deutschen chem. Gesellschaft, Jahrgang* iii, p. 946. W. G.

3. *On the basicity of uranic oxide, molybdic, boric and nitrous acids.*—Schultz-Sellack has found that the normal sulphates of antimony and bismuth may be easily prepared in an anhydrous state, by dissolving the oxide in moderately concentrated sulphuric acid and evaporating. Both salts crystallize in fine needles; they are respectively $Sb_2(SO_4)_3$ and $Bi_2(SO_4)_3$. On the other hand, uranic oxide, molybdic, boric and nitrous acids form analogous compounds, the formulas of which are:

$$(UO)_2SO_4,\quad (HUO)SO_4,\quad (UO)_2SO_4+SO_3$$
$$(MO)_2SO_4,$$
$$(HNO)SO_4,\quad (NO)_2SO_4+SO_3$$
$$(HBO)_2SO_4+SO_3.$$

The uranic and molybdic salts are crystalline; the boric salt is a thick fluid or glassy mass, which could not be obtained of constant composition. The analogy between some of the above salts and potassic dichromate is easily seen, when the formulas are written $(UO)_2S_2O_7$, $(NO)_2S_2O_7$, $(HBO)_2S_2O_7$. In a subsequent paper the author describes several other compounds of analogous constitution, which may be derived from the acid $H_2S_2O_7$, and some of which are new. The salt KHS_2O_7 may be obtained crystallized by dissolving $K_2S_2O_7$ in fuming sulphuric acid. It crystallizes in prisms which fuse at 168° C. The silver and barium salts have respectively the formulas $Ag_2S_2O_7$ and BaS_2O_7. The salts of arsenous and antimonous oxide, $As_2(SO_4)_3+SO_3$ and $Sb_2(SO_4)_3+SO_3$, or, as we should prefer to write them, $As_2O(S_2O_7)_2$ and $Sb_2O(S_2O_7)_2$, are both crystalline and easily decomposed by water.—*Berichte der Deutschen chem. Gesellschaft*, iv *Jahrgang*, p. 12 and 114. W. G.

4. *Researches on Vanadium.*—Roscoe has communicated to the Royal Society a further instalment of his very valuable and interesting researches on vanadium. Metallic vanadium absorbs hydrogen in quantities which vary according to the state of division of the chloride from which the metal is prepared (VCl_2) and of the metallic powder itself. When the compound is exposed to dry air it takes up oxygen, forming water and an oxide which has nearly the formula V_2O.

Vanadic oxytribromide, $VOBr_3$, is formed by passing the vapor of bromine over vanadic trioxide, V_2O_3, heated to redness. It is

a dark-red transparent liquid, which under a pressure of 100^{mm} of mercury volatilizes between 130° C. and 136° C. Its density at 0° C. is 2·9673.

Vanadic oxydibromide, $V\Theta Br_2$, is formed when the oxytribromide is heated above 180° C. It is a very deliquescent yellowish-brown solid resembling ochre. Heated in air it loses bromine and yields the pentoxide.

Vanadic tribromide, VBr_3, is a grayish-black opaque amorphous sublimate formed by passing dry bromine vapor over vanadic nitride heated to redness. It loses bromine on exposure to the air, and is very deliquescent.

Vanadates.—Roscoe finds that there are three classes of vanadates which may be termed metavanadates, pyrovanadates and orthovanadates. Sodic orthovanadate is formed by fusing vanadic pentoxide with sodic carbonate, dissolving in water and precipitating with alcohol. Its formula is $V\Theta_4Na_3+16\Theta H_2$. It is extremely unstable, being readily decomposed according to the equation:

$$2(V\Theta_4Na_3)+\Theta H_2=V_2\Theta_7Na_4+2NaH\Theta.$$

The orthovanadates are mostly insoluble compounds. Pyrovanadate of sodium has the formula $V_2\Theta_7Na_4+18\Theta H_2$, and is crystalline and easily soluble in water. When heated with carbonic dioxide it yields sodic carbonate and metavanadate:

$$V_2\Theta_7Na_4+C\Theta_2=2V\Theta_3Na+C\Theta_3Na_2.$$

The author describes various salts of vanadic acid, and points out the fact that the order of stability is at ordinary temperatures, first, metavanadates, second, pyrovanadates, and third, orthovanadates, which is exactly the reverse of the order in the case of the phosphates.—*Journal of Chem. Society*, vol. ix, p. 23. W. G.

5. *On a new platinum chloride.*—Sidney A. Norton has given a preliminary notice of a new chloride of platinum, discovered by him in Prof. Kolbe's laboratory. If one molecule of platinic chloride be mixed in aqueous solution with two molecules of silver nitrate, the yellow compound of platinous chloride with silver chloride $PtCl_2$, AgCl, described by A. Cammeille (C. R., lxiii, 553) is thrown down. The yellowish-red liquid above contains no silver; on evaporation, it evolves acid vapors abundantly, and when sufficiently concentrated, deposits on standing over sulphuric acid, beautiful large well-formed red crystals, which appear to be monoclinic in form. These crystals contain only platinum and chlorine—in the proportions of platinic chloride—and water. They are distinguishable from the ordinary platinic chloride by being non-deliquescent in the air—even slightly effloresing in dry air—and by the fact that their aqueous solution is not precipitable by ammonium chloride, until after long standing or on the application of heat. Norton suggests that this compound may be a hydrated platinic-oxide hydrochlorate, $Pt\Theta_2$, 4HCl, aq. or a chlor-platinic oxide hydrochlorate $(PtCl_2)O$, 2HCl, aq. isomeric with the ordinary hydrated chloride. Investigations now in progress will settle the

point for this as well as for other similar metallic compounds.—*J. pr. Ch.*, II, ii, 469, Dec. 1870. G. F. B.

6. *Synthesis of Oil of Rue.*—Gorup-Besanez and Grimm have lately succeeded in forming oil of rue synthetically. Starting from the fact first suggested by Hallwachs, and confirmed by Harbordt, that this oil is a mixed ketone of the formula $C\Theta\begin{cases} C_9H_{19}, \\ CH_3 \end{cases}$ since it is oxidized with difficulty and yields capric acid, they distilled together equal molecules of pure dry calcium caprate—prepared from a Hungarian wine-fusel-oil—and calcium acetate. The mixture melts, swells up, blackens, and evolves at first a fluid smelling like acetone, but afterward an oil which solidifies in the neck of the retort. By fractioning this distillate, three products were obtained: one boiling below 200°; another boiling between 210° and 245°; and a solid body, caprinon, boiling above 300°. The second fraction was purified by conversion into the double salt of ammonium sulphite, crystallizing from alcohol, and decomposing by sodium carbonate; a colorless, strongly refracting oil rose to the surface, which when dried, distilled completely between 223° and 224° and had at 17·5° C. a specific gravity of 0·8295. Commercial oil of rue, treated in the same manner, afforded a liquid distilling between 224 and 225·5° and having at 18·7° C. a specific gravity of 0·8281. Analysis of the ammonium double sulphite prepared from both, and of the pure oil both artificial and natural, gave the same result. Hence oil of rue consists essentially of methyl-caprinol or nonyl-methyl ketone.—*Ber. Berl. Chem. Ges.*, iii, 518, June, 1870. G. F. B.

7. *On the action of Chlorine upon Aldehyde. A new Chloral.*—With the intention of utilizing a waste product coming from the manufacture of aldehyde and consisting of alcohol and aldehyde essentially, Krämer and Pinner undertook its treatment with chlorine to see if it could not be converted into chloral. A flask containing 100 grams was placed in a freezing mixture and a slow stream of dry chlorine passed into it for 24 hours. The mass became thick and nearly doubled in volume. Subjected to distillation the greater portion passed over between 160° and 180°. This was purified by agitation with sulphuric acid and redistilled. It passed over between 163° and 165°, forming a colorless oily liquid, having a strong attraction for water, so that when mixed with it, heat was evolved and the mixture solidified to a crystalline mass. The same phenomena were noticed on mixing it with alcohol. Analysis gave numbers approaching closely both crotonyl-chloral and butyl-chloral; the authors are inclined to consider it the former, since Kekulé has shown that by removing a molecule of water from two of aldehyde, crotonyl aldehyde results. In this case, the chlorine first replaces hydrogen in the aldehyde, forming chlorhydric acid, which acid acts to withdraw water and thus condense the unattacked aldehyde to crotonyl aldehyde, in which the further replacements of hydrogen by chlorine occur. This new

chloral unites readily with water, as above stated, forming a solid which when crystallized from water, forms brilliant white silky plates which obstinately retain an excess of water. This crotonyl-chloral hydrate is easily soluble in alcohol and crystallizes therefrom unchanged. Its vapors are very irritating to mucous surfaces, attacking the eyes energetically. It melts at 78°. Treatment with potassium hydrate did not decompose it as it does common chloral, into allyl-chloroform and formic acid. A heavy oily fluid of peculiar odor collected at the bottom of the vessel, having the formula $C_3H_2Cl_2$. Upon oxidation with fuming nitric acid, it is converted readily into trichlorcrotonic acid $C_4H_3Cl_3O_2$. —*Ber. Berl. Chem. Ges.*, iii, 383, May, 1870. G. F. P.

8. *On the composition of the oil of the Palm-seed.*—Palm-oil is an orange-colored fat obtained from a palm tree growing on the west coast of Africa and called by botanists *Avoira elais* (Syn. *Elais guinensis*). The natives prepare it exclusively from the fruit-pulp, the hard stone in the interior being by them thrown away. Within a few years, however, these nuts have been brought to Europe and there expressed, yielding a more or less white oil, according to the care exercised. The seeds yield from 35 to 45 per cent of oil. A preliminary examination having shown that the fat of the palm-nut differed from palm-oil, OUDEMANS subjected it to investigation. One and a half kilograms was saponified with potash, and the fatty acids were separated from the soap with dilute sulphuric acid. After cooling they were removed and washed with cold water. The larger part was distilled with water in a tinned-copper flask, the distillate (about 4 liters) carefully collected and examined. It consisted of a clear liquid smelling like a volatile fatty acid (A) with a small quantity of a solid fatty acid (B) swimming upon it. The liquid was saturated with barium hydrate, by which a small quantity of a difficultly soluble barium salt (C) separated. The liquid was filtered and evaporated to 50 cc. On cooling, about a centigram of a crystalline barium salt separated, which proved to be barium caprylate. The mother liquor afforded barium caproate. The barium salt (C) was added to the fatty acid (B) also treated with barium hydrate, the whole boiled repeatedly with water and the crystalline deposits collected and recrystallized. On analysis they proved to be barium caprate. The caprylic, caproic, and capric acids thus obtained were not more than $\frac{1}{4}$ of one per cent of the fat. The residue in the copper flask was dissolved in aqueous alcohol, cooled to crystallize the fatty acids from oleic acid, the crystalline mass dissolved in alcohol and fractionally precipitated with barium acetate. In this way, the fat of the palm-nut was shown to be composed of glycerides of lauric, palmitic, stearic and oleic acids, with traces of tricaprin, tricaprylin, and tricaproin (perhaps also trimyristin). Quantitatively, Oudemans finds the triolein to be about 27 per cent, tristearin 31·7 and tri-laurin 41·3 per cent, of the fat of the palm-nut.—*J. pr. Ch.*, II, ii, 393, Dec. 1870. G. F. B.

II. Geology and Natural History.

1. *On the Mineralogy of Eozoon Canadense.*—Dr. Robert Hoffmann of Prague has submitted to chemical and mineralogical investigation the Eozoon Canadense, found at Raspenau in Bohemia, (*Jour. für prakt. Chemie*, May, 1869). He describes the Eozoon mass as having a superficial resemblance to that of Canada, appearing in waved or concentric bands, oval in form, or else in irregular acervuline aggregates. In the oval banded portion the shell of the Eozoon, a nearly pure, finely granular calcite, can be separated from the mineral representing the sarcode, which is described by Hoffmann as a cast of the soft parts of the Eozoon, formed through infiltration of watery solution either during the growth or immediately after the death of the animal. It is a peculiar silicate, fine-grained, grayish-white and somewhat translucent, the analysis of which is given below, (I). Associated with this is a finely granular dolomite, destitute of any traces of organic structure, which sometimes appears to have served as a center or point of attachment to the growing Eozoon. In other cases, however, broken fragments of older Eozoon had served as nuclei, and become surrounded with a fresh growth. These materials, which constitute what Hoffmann has described as the Eozoon reef, are associated with two other silicated minerals. One of these, allied to fahlunite, has a specific gravity of 2·687, is grayish-brown or greenish-black in color, dull, or with a somewhat fatty luster, and nearly opaque. This substance, whose analysis is given under II, forms nearly parallel streaks in the central parts of the Eozoon reef, and moreover surrounds it, intersecting and wrapping around the Eozoon mass in multiplied layers, a line or more in thickness, which are interlaminated with a light green mineral, transparent, with a somewhat vitreous luster, and a density of 2·56. It is a hydrous silicate (III), allied to picrosmine and is more or less penetrated by magnesite.

	I.	II.	III.
Silica,	53·388	36·425	52·677
Alumina,	10·521	32·944	1·260
Ferrous oxide,	10·091	20·140	1·011
Magnesia,	11·127	-----	30·414
Lime,	1·048	·678	-----
Potash,	1·378	2·721*	1·900
Soda,	2·094	-----	·233
Water,	10·991	7·092	11·865
	100·638	100·000	99·360

The band of Eozoon rocks at Raspenau lies between silicated schistose rocks beneath, and overlying beds of granular limestone, some of them grayish white, and others blackish from an admixture of carbonaceous matter. One of these gave to analysis 1·100 of carbon, 2·332 of insoluble matter, and 4·708 of carbonate of

* Akalies determined by loss; some soda was present.

magnesia, the remainder being carbonate of lime. The composition of the Eozoon shell is given under IV, that of the dolomite under V, and that of the magnesite which penetrates the silicate, III, under VI.

	IV.	V.	VI.
Carbonate of lime,	97·711	53·815	5·581
Carbonate of magnesia,	traces	40·420	84·651
Carbonate of iron,	1·660	-----	1·001
Alumina,	·629	-----	8·767
Insoluble,	(phosph. traces)	1·260	-----
	100·000	95·495	100·000

T. S. H.

2. *On a Mineral Silicate injecting Paleozoic Crinoids;* by T. Sterry Hunt, F.R.S.—A Silurian limestone from near Woodstock, New Brunswick, lately examined microscopically by Dr. Dawson, was found by him to consist almost wholly of comminuted organic remains, including fragments of trilobites, gasteropods, brachiopods, and joints of small encrinal stems and plates; the whole cemented by calcareous spar in a manner similar to many organic limestones. He observed, however, that the pores of the crinoidal remains were injected by a peculiar mineral, readily distinguishable in thin transparent sections, or on surfaces which had been exposed to the action of an acid, which dissolves the carbonate of lime and places in relief the injecting mineral. The minute structure thus revealed is precisely similar to that of recent crinoids studied by Carpenter, and will soon be described and figured by Dawson. Decalcified specimens exhibit a congeries of curved, branching and anastomosing cylindrical rods of the replacing mineral, sometimes forming a complex network, which, under the microscope, resemble the coralloidal forms of aragonite known as *flos ferri*, and present a frosted crystalline surface. The same mineral, as observed by Dr. Dawson, occasionally occupies larger interstices among the fragments, and was evidently deposited before the calcareous spar which cements the whole mass.

When this limestone is dissolved in dilute hydrochloric acid, the residue, washed by decantation, equals from five to six per cent of the weight of the mass, and is seen under a microscope to consist entirely of the casts composed of the mineral just noticed, mixed with about one-fourth of coarse siliceous sand. This matter is pale grayish-green in color, but when calcined becomes of a bright reddish-brown, without change of form. Heated in a close tube it gives off water, and becomes much darker in color. It is partially attacked by strong hydrochloric acid, which takes up much protoxide of iron; but is readily and completely decomposed by hot concentrated sulphuric acid, leaving a skeleton of silica which, by a dilute solution of soda, is readily separated from the intermingled grains, more or less rounded, of colorless vitreous quartz. The analysis of 1·187 grams, effected by decomposing it in the way just mentioned, yielded silica ·3290, alumina ·2440,

protoxide of iron ·1593, magnesia ·0360, potash ·0140, soda ·0042, water ·0584, insoluble quartz ·3420=1·1869. This calculated for 100·00 parts of the silicate gives as follows; silica 38·93, alumina 28·88, protoxide of iron 18·86, magnesia 4·25, potash 1·69, soda 0·48, water 6·91. The analysis of another portion of ·526 grams by fusion with an alkaline carbonate gave, by calculation for the silicate, 18·80 of protoxide of iron, and amounts of alumina and combined silica closely agreeing with those found above. The oxygen ratio for $\dot{S}i$, $\dot{R}$, $\dot{R}$, $\dot{H}$, is as 20·77 : 13·46 : 6·29 : 6·14, or nearly as 3 : 2 : 1 : 1. This mineral approaches closely in composition to jollyte, but differs from it in containing a portion of alkalies, and but one half as much water. In these respects it agrees closely with a silicate found by Robert Hoffmann with the Laurentian Eozoon of Raspenau, (Jour. für prakt. Chem., May, 1869, and this volume, page 378). This latter is compared by Hoffmann to fahlunite, to which species also jollyte is allied in physical characters as well as in composition (Dana's Mineralogy, page 493.) Under the names of fahlunite, pinite, etc., is included a great class of hydrated silicates, which, from their imperfectly crystalline condition, have generally been regarded, like serpentine, as the results of the alteration of other silicates. It is, however, difficult to admit that silicates found in the condition described by Hoffmann, and still more the present mineral, which injects the pores of paleozoic crinoids, can be any other than original depositions, allied in the mode of their formation to the serpentine, pyroxene and other minerals which fill the chambers and canals of the Laurentian Eozoon, and to the glauconite which occurs in a similar manner in Tertiary and recent shells. The limestone from Woodstock, apart from the insoluble matters just described, is very pure, yielding only 1·80 p. c. of alumina and iron-oxide, and magnesia equal to 1·35 p. c. of carbonate.

Montreal, March 10, 1871.

3. *On native amorphous Mercuric Sulphide.*—G. E. Moore has recently examined a specimen of black mercury-ore collected in Lake county, California, by Professor Whitney. It occurs as a coating on the sides of cracks and crevices in a peculiar quartzose gangue, and is accompanied by crystallized and massive iron and copper pyrites, and very minute cochineal-red crystals of cinnabar. Its physical properties are thus given:—Entirely without structure or cleavage. Fracture semi-conchoidal to uneven, fracture-surfaces brilliant. Very brittle when struck or bent, yet tough when cut. Rubbed in an agate mortar the powder becomes a solid mass, taking a high polish and a metallic luster like graphite. Color grayish-black. Luster metallic. Streak on porcelain pure black. Cut surfaces brilliant. Hardness about 3 on Mohs's scale, somewhat greater than cinnabar, though difficult to estimate exactly on account of its brittleness. Specific gravity 7·701 to 7·748; somewhat different in different specimens on account of admixed cinnabar. Before the blowpipe it behaves like cinnabar. In the closed tube, it sublimes completely, with the exception of a trifling residue of quartz and iron oxide. The black sublimate yields a

cinnabar-red powder when care is taken that the upper part of the tube is heated to near the subliming point of the cinnabar. A qualitative analysis showed mercury and sulphur, with small quantities of iron and silica. Quantitatively examined it yielded as follows:—Sulphur 13·82, mercury 85·79, iron 0·39, quartz 0·25. Whence its composition is

HgS, 98·92; FeS_2, 0·83; Quartz, 0·25 = 100·00.

Experiments to determine the chemical cause of the difference in properties between this mineral and cinnabar, resulted negatively. Moore concludes that the mineral in question is completely identical with the black amorphous mercuric sulphide of the laboratory, and proposes for it the name Metacinnabarite.—*J. pr. Ch.*, II, ii, 319, Nov. 1870. G. F. B.

4. *Freieslebenite and Diaphorite.*—Von Zepharovich has shown (Sitz. Acad. Wiss. Wien, 1871), that Freieslebenite includes two species of similar composition ($Ag_4Pb_3Sb_4S_{11}$) but different crystallization. He retains the original name for the *monoclinic* species and gives the name diaphorite to the *orthorhombic*. The former is from Freiberg and Hiendelaencina in Spain, and has for the ratio of the inclined diagonal, the orthodiagonal and the vertical axis 1 : 0·5871 : 0·9277; and the inclination of the last is 87° 46′; sp. gr.=6·35. The diaphorite is from Przibram and Freiberg, and has for the ratio of the diagonals and vertical axis 1 : 0·4919 : 0·7344; and sp. gr.=5·90.

5. *On the Eocene beds of Utah;* by T. A. Conrad. (From the author.)—I am indebted to Prof. Cope for an opportunity to examine some Eocene fossil shells, collected at Aspen station, and at Quaking Asp Ridge, east of Bear river, Utah, at an elevation of 7,100 feet. These fossils were taken from the rock in which they were imbedded, by Lucius C. Ricksecker, engineer on the Pacific Railroad. They are imbedded in indurated clay, and suggest the probability that they lived in a river rather than a lake, especially as there is a genus of Cyrenidæ (*Veloritina* Meek) as well as one of Corbulidæ (*Anisorhynchus* Conrad) which lived apparently in company with Unionidæ and Melaniidæ. These fossils are especially interesting in consequence of the light they cast on the condition of the globe in the earliest Eocene period. This group immediately overlies the Cretaceous strata, and corresponds with the Lignite beds at the base of the Paris Eocene and those of Provence described by Matheron, which is the first supracretaceous group of strata known to occur in Europe, and according to Matheron has a "colossal development;" and of his first stage of Lignite, he remarks that where the lower bed is in contact with the chalk, it shows fragments of marine shells not easily determined, but he recognizes *Ostrea* and *Cardium*. This is probably the broken up surface of the Cretaceous formation which emerged above the sea, a condition naturally following the agitation of the waters of a retiring ocean. Upon this bed follows five stages of Tertiary Lignite of fresh water origin, the lower beds containing *Unio Toulouzanii* (*Loxopleurus* Meek), *Cyrena globosa*, and *C. Fesrusssaci*. This mixture of fresh and brackish water genera corresponds with

the lowest beds of the Eocene in North America. This exact correspondence in stratigraphical position between the European and American older Eocene, as well as in the hydrography and topography of the respective continents at that period, is elucidated by the affinity of the fossils as regards their peculiar generic characters. Thus the genus *Loxopleurus* Meek originated and died out with the older Eocene fauna. This was also the case with *Veloritina* Meek, a genus closely allied to if not identical with a genus which Deshayes regards as *Cyrena*, but arranges in a separate section (*C. Trigones*). He describes ten species of the Paris basin and Matheron one from Provence (*C. globosa*). This genus is unknown in later Eocene strata. A gasteropod of the family Melaniidæ cannot be distinguished generically from one in the Lignite beds of Provence, named *Melanopsis armata* by Matheron. This is the *Tiara* (*Pyrgulifera*) *humerosa* Meek. It is a well characterized genus, very distinct from *Tiara* and more nearly related to *Melanopsis* Ferrus. It is also limited to the lower Eocene, and was probably an estuary or brackish water shell, although its nearest living form is *Varena crenocarina*, which inhabits the Pedro Branca river, Bahia. *Loxopleurus* Meek is related on one side to *Castalia* and on the other to *Trigonia*, which latter genus apparently became extinct in the Cretaceous era, for it is unknown in Tertiary formations, and reappears in the actual seas with very different external characters and I think without genetic descent from the fossil species.

The marine equivalent of this lower Eocene formation is probably to be found in the division B, of Mr. Gabb's Cretaceous fossils of California.

The hydrography of this early Tertiary era may be imagined from the foregoing statement to have been a river system analogous to that of Brazil at the present time. The presence of vast numbers of estuary shells forbids us to suppose that the group inhabited lakes rather than rivers, which rose in not greatly elevated hills, for mountains, except as isolated peaks, had hardly been developed at this period, when the great basin of Utah was submerged, and the Mississippi valley and its rivers were not yet formed, but the general drainage was into the Pacific ocean. There was then a system of great rivers and a densely wooded country eminently fitted for land animals, whose remains I have no doubt are to be found, if they have not been already obtained. The elevation of this vast region to any considerable height took place in the first stage of the Eocene era, and if we are surprised at the great extent of such brackish water rivers, we have only to glance at a similar river system 2,200 miles up the Amazon. By the rise of the Cretaceous formation, this condition of the country was formed, and as no transition beds are known, the advent of new genera and species so different from what had lived before is an unexplained phenomenon in the geological history of the globe.

So far in Europe, I believe, no authentic account has been published of any fossiliferous beds between the lower Eocene and the Cretaceous strata, that would indicate a transition period to have

intervened. And so in Utah, Idado and Wyoming, the same remarkable condition is apparent, as it is in the Eastern States, in England, France, Spain, India, on the banks of the Nile and in South America, which proves that the revolution which closed the Cretaceous era was co-extensive with the globe and destroyed the life of the period.

6. *Coal Plants of the Illinois Geological Survey, 4th Volume.*—Mr. Lesquereux's chapter on coal plants, in the fourth volume of the reports of the Geological Survey of Illinois, embraces descriptions of 78 new species. It also includes remarks upon numerous instructive specimens of previously described species (40 of which had not before been recognized in America), and is, as a whole, the most valuable contribution to the history of our American coal plants which has appeared since the publication of the Pennsylvania Report in 1858.

At the close of the descriptive part of the report (p. 471), the author gives the list of the species of plants thus far identified from the Illinois coal field, showing their geographical distribution. This, however, is not to be considered an estimate of their *actual* distribution, as the author states, because of the very extensive explorations at one or two points, and the almost entire neglect of large portions of the field which would probably, if explored, yield fully as rich collections.

The report closes with a pretty full discussion of the "Mode of Preservation of Vegetable Remains in our American Coal-measures," of the "Affinities of the Illinois Coal-flora," and of the "Stratigraphical and Geographical Distribution of the Coal-flora."

We have here mention of the fact that plants are sometimes found in good preservation in the solid coal, as well as in the disintegrated form of mineral charcoal which often occurs between the layers of the denser coal. "This [former] case is especially observable in a kind of hard laminated flint coal, obtained in Mercer county by Mr. H. A. Green [of the Survey], which bears on the horizontal surface of its crystalline lamellæ, however thin they may be cut, the outline and nervation of leaves and branches of ferns and other vegetables of the coal; and these are so distinctly marked that the most delicate parts are as easily identified as those of plants preserved in shales. The great abundance of these remains shows that the whole mass of this coal, which is true coal and burns freely, is a compound of them.

In shales, the leaves of ferns and other plants are sometimes finely preserved in the form of extremely thin layers of coal; while, in other cases, the carbonaceous matter has nearly disappeared, leaving barely enough to show the outlines of the fossil. In still other cases, we find larger or smaller fragments of the cuticle of plants, not completely altered to coal, of a reddish-brown color, and retaining considerable elasticity. "The shales, according to the amount of vegetable matter mixed in them, and the depth at which they have been formed under water [?], are of a more or less dark color; whitish or yellowish, when of fresh water origin, and with few remains of plants; black and generally more homogene-

ous when formed in deep water, and having, for a larger proportion of their compound, broken remains of organized beings."

The author is not satisfied to refer to ordinary concretion or segregation, the formation of the ironstone nodules from Mazon Creek, which have yielded so many ferns, insects, crustaceans, etc. He says:—"from their position, their form and size, varying according to the nature and outline of the bodies which they contain, the nodules of Mazon Creek rather seem to be the work of infusoria or *Bacillaria* concentrating molecules of iron around some centers, as now happens in the formation of bog iron ore, or in other deposits in springs or pools whose waters contain a solution of iron. This supposition appears confirmed by the manner in which the bodies in concretions have been preserved and selected for preservation. Though generally merely fragments, their integrity is complete; and yet some of them are of very soft texture. The pinnæ or leaflets of ferns are always found in them in a flattened position, their axis or rachis extending through the center of the elongated nodule, with the divisions on both sides; the surface of the pinnules slightly swollen, as when in their living state, is marked by recognizable hairs or fruit dots, with distinct veins and vainlets; and their appendages, like the scales, are seen in the various modifications which they present in the living specimens. * * The small organs of plants appear, then, in a better state of preservation than in the shales. With small animals like crustaceans, scorpions, insects of a fleshy and very delicate texture, the preservation of form is still more remarkable. They are found entombed in the middle of the nodules just as if they were in life, or as if they had been transformed into stone while still living. The fruits or nutlets are not flattened. * * Peculiar species of plants and animals seem to have been selected as the nuclei of these nodules," certain forms which are abundant in them being scarce or entirely wanting, so far as observed, among the fossils of the shaly portion of the same bed at Morris five miles off, and *vice versa*. F. H. B.

[We propose to continue this notice in another number.]

7. *The Bone Cave of Eastern Pennsylvania* (p. 335).—Recent letters from Mr. WHEATLEY state that the cave is constantly making new disclosures. He writes:

Of Megalonyx, I have 30 to 40 teeth and 3 in the *jaw;* and parts of 17 individuals of the sloth tribe. Prof. Cope has this day read a paper before the American Philosophical Society describing the following species of vertebrates: *Megalonyx splenodon* Cope, *M. tortulus* C., *M. toxodon* C., *M. Wheatleyi* C., *M. dissimilis* Leidy; *Mylodon Harlani* Owen; *Arvicola hiatidens* C., *A. sigmodus* C., *A. pinetorum* LeConte, *A. involuta* C., *A. speothen* C.; *Hesperomys ? leucopus* Raf.; *Jaculus ? Hudsonius* Temm.; *Erethizon cloacinus* C.; *Sciurus calycinus* C., *S.* ——*?; Lepus sylvaticus* Bachm.; *Scalops ?* ——*?; Vespertilio ?* ——*?; Tapirus Americanus* Brisson, *T. Haysii* Leidy; *Mastodon Americanus* Cuv.; *Bos* ——*?; Equus* ——*?, E.* ——*?; Ursus pristinus* Leidy; *Felis* ——*?; F.* ——*?; Canis* ——*?; Crotalus* ——*?, Coluber* ——, *C.* ——*?; Tropidonotus* ——*?; Cistudo* ——*?; Emys* ——*?; Rana* ——*?,*

Meleagris —— *?*, *Scolopax* —— *?;* not identified 3. The whole number is 41 species; 6 of them Edentates, 12 Rodents, 1 Insectivore, 1 Chiropter, 8 Ungulates, 4 Carnivores?, 2 Birds, 6 Reptiles, and 1 Batrachian. Dr. G. H. Horn has examined the insects and has recognized among them the following species: *Cychrus Wheatleyi, C. minor; Cymindis aurora; Chlænius punctatissimus; Pterostichus lævigatus, Pt. longipennis; Dicælus alutaceus; Aphodius scutellaris, A. micans; Phanæus antiquus; Copris punctulatus; Saprinus? ebeninus.* He also observes that there are several others which he does not venture to name.

8. *On Fossil Vertebrates of Caves on the Island of Anguilla, W. I.;* by Dr. Cope, (Proc. Amer. Phil. Soc., Nov. 18, 1870).—These vertebrates include a crocodilian, two birds, one deer and five rodents. Three of the rodents were of gigantic size, and included, besides two species of Chinchilla already described (loc. cit., 1869, 193) a third, still larger, the *Loxomylus latidens* Cope. The bones of the deer indicated a species little over half the size of the Chinchilla.

9. *Report on the Progress of the State Geological Survey of Michigan;* presented Nov. 22, 1870, by Alexander Winchell, Director. 64 pp. 8vo. Lansing, 1871. Published by authority of the State.—The survey of Michigan now in progress was ordered by the State in 1869, when $8,000 per annum were appropriated for the purpose. The appropriation was to be divided equally between the surveys of the Upper and Lower Peninsula, and in this way the work has now been carried forward for two years. Toward the survey of the Marquette district, Major T. B. Brooks has been engaged, and for the copper region, Professor R. Pumpelly.

The pamphlet issued is only a brief statement of the objects of the survey and of some of its results. Among the facts mentioned under the head of General Geology are the following.

The water-lime group of the Lower Helderberg rocks occurs in the State near the west end of Lake Erie in Monroe Co., and also on Mackinac Island, and the mainland of the Upper Peninsula to the west. The Huron group of rocks, as Prof. Winchell has before announced, is referred by him to the Portage and Chemung, and the Marshall group to the Subcarboniferous.

Among the western and northwestern borders of the Lower Peninsula, the *boulder drift* is underlaid by "vast horizontal beds of bluish and pinkish clays, nearly free from boulders, and diversified with occasional seams of lignitic and soil-like material," which rest on the scratched rocks. The boulder deposits are distributed through beds of obliquely laminated sands and clays, and on these rest the lakes and peat bogs of the State. In these upper deposits are found remains of the elephant, mastodon, and Castoroides.

Prof. Winchell also mentions the discovery of *an ancient outlet of Lake Superior* through the valley of Au Train and Whitefish rivers into Little Bay de Nocquet and Green Bay of Lake Michigan; it is a deep valley bordered with high bluffs, mostly limestone at bottom, across between Lake Superior and Little Bay de

Nocquet. He adds, "It may easily be that the elevation (of the ancient valley), is just such as to justify the project of a ship canal across the divide, with the view of shortening the voyage" between the ports of the two lakes. This outlet lies in the prolongation of the axis of Green Bay, "and recalls opinions formerly entertained, based solely on topographical data, that Green Bay was once prolonged through Lakes Winnebago and Horicon in Wisconsin." This elongate hydrographical basin conforms in its longer axis with the direction of the glacial striæ and boulder transportation.

10. *Note on Limestone containing Petroleum in Nova Scotia;* by D. HONEYMAN, (Edit. Corr., dated Halifax, Nova Scotia, Provincial Museum, March 28, 1871).—We have recently received a quantity of Lower Carboniferous limestone from Kempt in this province, having numerous cells with small crystals of calcareous spar and petroleum. When the limestone is broken, you almost invariably find the cells with the petroleum, the latter having a honey-like appearance. The limestone is in connection with gypsum.

11. *New York State Cabinet of Natural History:* 20th Report. 1867. 448 pp. roy. 8vo, with numerous plates and wood-cuts.—This beautiful volume is a reprint of the State Cabinet Report for 1867, or rather it is from a revised edition of it. It is the most extended and valuable of the series, and well deserved reproduction in a better form. A notice of it appeared in this Journal in vol. xlvi, 1868. It contains Hall's admirable paper on the Graptolites, illustrated with many wood-cuts and four plates; descriptions of a very large number of fossils of the Niagara group, with figures of the species on 21 excellent plates; also several shorter papers. Some of the latter are controversial, and have already been the subject of remark in this Journal.

12. *Saurocephalus of Harlan.*—Dr. COPE observes (Proc. Phil. Soc., Nov. 18), that the genus *Saurocephalus*, instituted on Cretaceous fishes, instead of being Acanthopterygian, is Malacopterygian, and between the Salmonidæ and Amiidæ. The spines and rays have been regarded by some authors as of the Cestraciont genus *Ptychodus.*

13. *Geology of Ohio.*—We understand from Prof. Newberry, the director of the Geological Survey of Ohio, that another Annual Report is ready for the press. If the plans of Dr. Newberry are sustained and carried out by the State, Ohio will not be behind Illinois in the character of its final Report.

14. *Note on Asaphus platycephalus, by* J. D. DANA.—The closing remark in my paper on page 321 will have to be canceled, if the species, there referred to *Asaphus platycephalus*, is identical with the *Asaphus platycephalus* (*A.* (*Isotelus*) *gigas*), of Trenton, the latter (as Mr. Billings writes the author) often occurring in New York rolled into a ball.

15. *On the Earthquake at Oahu, Hawaian Islands, on Feb.* 19; by Professor W. D. ALEXANDER. (From a letter to J. D. Dana, dated Oahu College, Feb. 28, 1871).—We have a letter upon this earthquake, by Professor Alexander, of Honolulu, which will appear in our next.

16. *Claparède on Marine Bryozoa.*—In the first number of vol. xxi of Siebold u. Kölliker's Zeitschrift, Claparède, who with the exception of Nitzsche is the only writer who has studied the Bryozoa since the publication of the capital papers of Smitt, gives us most interesting contributions to their history. While on the main points he completely agrees with the views taken by Smitt of the polymorphism of the species, their mode of budding and general embryonic development, yet in some points not satisfactorily determined by Smitt, such as the relations of the various cells (zoœcia) to one another, the nature of Smitt's "mörka kroppar," dark bodies, and "fett kroppar," he has new observations differing somewhat from those of Smitt. The most interesting facts are those concerning a sort of retrograde development, a resorption of the digestive cavity in the older cells, the gradual disappearance of the lophophore, resulting in cells usually considered as dead, but in reality having latent life, and where alone the fatty bodies of Smitt, which play such an important part in the embryology of Bryozoa, are developed. These cells apparently pass through stages identical with those produced by budding at the youngest extremity of the colony, with the difference that in one case the cell is immature, while in the other it is fully developed. The resorption is frequently accompanied by peculiar changes in these cells, and is confined to the older portions of the Bryozoan colony in which the lateral connection between the cells for exchange of fluids between the cells provided with digestive cavities and those cells containing latent life, is very strikingly shown, thus forming a complete circulation between the most distant parts of the colony. He also confirms the nature of the colonial nervous system, first traced by Fritz Müller, and shows its existence among the Chilostomata, where it had only been traced by Smitt before. Claparède closes this interesting paper by giving us the complete development of Bugula, with larger, more accurate, and at the same time more intelligible figures than we have had of the early development of any one species of marine Bryozoa thus far. He has, however, not been able to decide positively the nature of the ova, said in one case to owe their origin to a sexual process, and in the other cases to point to the existence of parthenogenesis among Bryozoa, under certain circumstances. Claparède has not confirmed the observations of Schneider on the development of Membranipora, but from what Nitzsche has observed of the early stages of Bugula, he appears to have seen the same retrograde development in the youngest stages of its larva which Schneider observed in Cyphonantes during its development into Membranipora. A. AG.

17. *Ceratodus, its place in the system of Fishes.*—The *Ceratodus Forsteri* of Krefft (Proc. Zool Soc., 1870, 221), a fish from Australia supposed to be congeneric with the *Ceratodus* of Agassiz from the Devonian, first made known by Hon. Wm. Foster three years since, has been recently studied by Dr. Günther, and an extended memoir on it has been presented by him to the Royal Society. We take the following facts from an abstract of this memoir

in the Ann. Mag. Nat. Hist., IV, vii, 222. The skeleton is of the type so well known from the descriptions of *Lepidosiren* and *Protopterus* by Owen, Bischoff and Hyrtl. The teeth are much like those of *Protopterus*, *Psammodus*, *Dipterus*, etc., in microscopic structure, and identical with those of the fossil *Ceratodus* —confirming thereby Mr. Krefft's reference of the fish to the last mentioned genus. Dr. Günther names a second Australian species *Ceratodus miolepis*.

Messrs. A. Hancock and T. Atthey have an article on the subject in the same volume of the Ann. Mag. Nat. Hist., p. 190, in which they present the conclusion that, while the fish referred to is nearest to *Lepidosiren*, it is probably more distinct in genus from the Devonian *Ceratodus*, than from *Ctenodus* and *Dipterus*, especially the former (these two genera for reasons stated being kept separate). *Ceratodus*, they observe, "is probably a true Cartilaginous fish, and consequently a Selachian or Placoid," and the fact that only its dental plates are known, nothing of the bony supports of the same having been found, is urged as sustaining this view.

18. *Coccoliths.*—*Coccoliths*, calcareous disk-shaped organisms, regarded by Huxley at first as a unicellular plant (alga), and afterward the secretions of his Bathybius (analogous to the siliceous spicula of a sponge) have been recently examined by H. J. Carter (Ann. Mag. Nat. Hist., IV, vii, 184), and found to be what they were first pronounced. Carter finds them very abundant in shallow waters as well as profound depths. After mentioning the results of chemical examinations in which he found a "granular protoplasmic disk remaining after the action of acetic acid, he adds:

"Thus, still more convinced that I had a unicellular Alga under examination, and taking a portion of the little arborescent fronds of *Melobesia calcarea* ("the chalk-*Melobesia*"), which, in about ten fathoms, occurs here in accumulated beds or banks of probably miles, certainly acres, in extent, I pulverized a portion for examination, and observed several fragments whose cells, but for their polygonal arrangement, presented very much the appearance of the coccolith in their concentric lines, transparent area and central granule, together with the absence of blue color under the iodine test.

Lastly, considering that the coccolith is so abundant in the Laminarian zone here, and so voraciously fed upon by the Echinodermata and Ascidiæ, also that it is so nearly allied in composition, structure, and habit to *Melobesia calcarea*, that it chiefly forms the bed of the Atlantic ocean, and that it is found fossilized in the chalk, I cannot help inferring that it is a vegetable organism which contributes chiefly to form the calcareous deposits of the present day in many parts, and has done so in the formation of calcareous ones of the past, at all events that of the chalk."

He names two species *Melobesia unicellularis*, from the Atlantic ocean bottom, and also the Laminarian zone on the South coast of Devon, and *M. discus*, from the Atlantic ocean, each stated as "accumulating in beds." The cell in each is described as calcareous, discoidal or discal, transparent, convexo-concave, consisting of two convexo-concave disks, one a little larger than the other and receiving the smaller one in its concavity, and enclosing a granular protoplasmic disk, with a central transparent area. The first is obtusely elliptical, and about $\frac{1}{1700}$th in. long and

$\frac{1}{12000}$th in. thick; the second is circular and about $\frac{1}{2300}$th in. in diameter. The latter is not found in the Laminarian zone.

Coccospheres of Huxley are of two kinds, and are made up of frustules of the above species, the two different kinds never occurring mixed in one coccosphere. Carter regards the coccospheres as the "*sporangia* of the two species of *Melobesia*." Besides the two distinct kinds of coccospheres, there are also the "loose type" of coccospheres of Huxley. This, Mr. Carter has not seen, but he conceives that they may represent more developed form of the sporangium or coccosphere, perhaps undergoing dehiscence.

The coccoliths must furnish food for the lower animals over the bottom of the deep sea, as they do for those along its borders.

19. *Transactions of the Connecticut Academy of Arts and Sciences*, Vol. I, Part 2. 376 pp. 8vo, with 7 lithographic plates. New Haven, Feb., 1867 to March, 1871.—This work has been much delayed by a fire, by which most of it was destroyed in 1869. It is entirely occupied by the "Notes on the Radiata in the Museum of Yale College," by A. E. Verrill. Under this head there are nine distinct articles: No. 1, Descriptions of New Starfishes from New Zealand; No. 2, Notes on the Echinoderms of Panama and west coast of America, with Descriptions of new Genera and Species; No. 3, On the Geographical Distribution of Echinoderms of the west coast of America, with a Comparison of the Tropical Echinoderm-Faunæ of the east and west coasts of America; No. 4, Notice of the Corals and Echinoderms collected by Prof. C. F. Hartt at the Abrolhos Reefs, Province of Bahia, Brazil, 1867; No. 5, Notice of a collection of Echinoderms from La Paz, Lower Cal., with Description of a new Genus; No. 6, Review of the Corals and Polyps of the west coast of America (six plates); No. 7, On the Geographical Distribution of the Polyps of the west coast of America; No. 8, Additional Observations on Echinoderms, chiefly from the Pacific coast of America; No. 9, On the Echinoderm-Fauna of the Gulf of California and Cape St. Lucas. All these articles, except the three last, have been noticed in this Journal, from time to time, when they have been published as separate pamphlets.

Nos. 6 and 7 have also been issued under one cover, forming a pamphlet of 193 pages, with six plates. The early parts of No. 6 were noticed in this Journal last year. In the portion describing the Madreporaria several changes have been introduced in the classification, of which the most important is the institution of a new sub-order (*Oculinacea*) to include *Stylasteridæ* Gray (emend.), *Oculinidæ*, *Pocilliporidæ* Gray, *Stylophoridæ*, *? Stylinidæ*, *Astrangidæ*, *Caryophyllidæ*. Several changes are made in the limits and characters of the families and genera: *Madreporidæ* is made (as by Prof. J. D. Dana) to include both *Madrepora* and *Montipora*; *Astrangidæ* is extended so as to include *Cladocora* and its allies; the *Caryophyllidæ* of Edw. and Haime are divided into two families, the second division, *Turbinolidæ*, corresponding nearly with *Turbinolinæ* E. and H.; *Agaricidæ* Gray (emend.) is adopted instead of *Lophoseridæ*. The relations of *Pocillipora*

are discussed anew, and the author's view, previously expressed in other works,* that *Pocillipora* is a true Polyp, and not at all allied to *Millepora* and other Hydroid corals, is again insisted upon, and the relations of the *Pocilliporidæ* to certain fossil corals is discussed. "Its affinities with numerous extinct genera having the same tabulate structure, is a matter requiring a great amount of careful investigation. From *Favositidæ*, as a whole, it differs in having an abundant cœnenchyma. *Favosites* differs also in having perforate walls, and doubtless ought to be separated, at least as a distinct family, which has, perhaps, closer relations with *Madreporacea*."† A number of new corals are also described and, in the Addenda, some additional new *Gorgonidæ*.

In No. 7, lists are given of the species found in each of the faunal divisions of the west coast, with their range, etc., and in some cases special local lists are added. In the Panamian Fauna 104 species occur, none of which have been found beyond the limits of that zoölogical province. The plates are chiefly devoted to the Gorgonacea, and two of them illustrate the spicula of many species.

20. *Second and Third Annual Reports of the Trustees of the Peabody Academy of Science for* 1869 *and* 1870, Salem, Mass., received March, 1871.—This report contains the services on the occasion of dedication of the Museum, with the address of the President of the Academy and remarks by others; the Proceedings of the Trustees; the annual reports of the officers of the Academy; lists of Additions to the Museum; and an Appendix containing several zoölogical articles. Prof. A. Hyatt gives an account of a specimen of *Rossia palpebrosa* Owen (?) taken from the stomach of a hake at Manchester, Mass.,—a species not before recorded from our coast. Prof. E. D. Cope contributes a Catalogue of Batrachia and Reptilia obtained by J. A. McNiel in Nicaragua, and another of those obtained by C. J. Maynard in Florida; in the former article he describes a new lizard and a new genus and species of serpents (*Enulius murinus*); in the latter a new lizard and a new salamander (*Manculus remifer*). Prof. A. S. Packard gives a list of the Insects collected at Pebas, Ecuador, by Prof. J. Orton, and describes a new species of *Attacus* (*A. Amazonia*). Mr. S. I. Smith contributes a list of the Crustacea collected by J. A. McNiel in Central America, and describes a number of new species belonging to the genera, *Leptopodia*, *Ozius*, *Arenæus*, *Gebia*, *Atya* (2 sp.), *Evatya* (new genus), *Leander*, and *Palæmon*. Several species in the collection appear to be identical with Atlantic species. The omission of the precise dates of publication of these descriptive papers is inexcusable. The report is merely dated "1871."

* On the Affinities of the Tabulate Corals, in Proc. Amer. Assoc. for Adv. of Science, 1867, p. 148; also Proc. Essex. Institute, vi, p. 90, 1869.

† Since the printing of these remarks (April, 1870), a very interesting new genus of recent tabulated corals has been described by Mr. W. S. Kent, under the name of *Favositipora Deshayesii* (Ann. and Mag. Nat. Hist., vol. vi, p. 384, pl. 17, 18, Nov., 1870). This remarkable form combines a complete tabulate structure of the interior, like *Favosites*, with the ordinary structure of *Alveopora* in other respects, thus fully confirming the views quoted above.

21. *On the Genesis of Species;* by ST. GEORGE MIVART, F.R.S. 296 pp., 12mo, with numerous illustrations. London, 1871. (Macmillan & Co.)—This work presents the fairest and most successful argument against the sufficiency of the theory of "Natural Selection" which has thus far been published. At the same time, the author, in his two closing chapters, sustains the view of an evolution of species by secondary laws; but laws "for the most part unknown," and among which that of "Natural Selection" is only of subordinate importance. The illustrations are excellent.

III. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Anthracite Coal Trade of Pennsylvania.*—Mr. PETER W. SHEAFER, a well known engineer at Pottsville, Pa., has prepared a diagram exhibiting the progressive development of the Anthracite Coal Trade of Pennsylvania. It embraces the period of fifty years from 1820 to 1870, and an accompanying table gives in detail for each year, the yield of anthracite of the four great subdivisions of the anthracite region, the Lehigh, the Schuylkill, the Wyoming, and the Lykens Valley, Shamokin, etc. We take the export in tons, for the years below specified, from the table:

	Lehigh.	Schuylkill.	Wyoming.	Lykens V., etc.	Total.
1820	365				365
1830	41,750	89,934	43,000		174,734
1840	275,313	475,091	148,470	15,505	864,384
1850	690,456	1,782,936	827,823	57,684	3,358,899
1860	1,821,674	3,270,516	2,941,817	479,116	8,513,123
1870	3,172,916	3,853,016	7,825,128	998,839	15,849,899

The Schuylkill trade began in 1822, with the exportation of 1,480 tons; the Wyoming, now twice the largest, in 1829, with 7,000 tons; the Lykens Valley, etc., in 1839, with 11,930 tons.

2. *Carbonic acid in outside and indoor air.*—According to examinations made at the Massachusetts Institute of Technology, by A. H. Pearson, under the direction of Prof. Storer, the amount of carbonic acid in the air at the Cupola of the State House, Boston (May 18, 1870), was ·03139 per cent of volume; in Newbury st., Boston, near the Institute of Technology, out of 11 trials on different days, ·03798 to ·04999, and on one day (April 1), ·03194; in Clarendon Place, near Berkely st., ·03371. According to the same experimenter, the volume of carbonic acid in the air of a recitation room of the Institute, after recitation, [we omit the date], was found to be ·08929 to ·09762 p. c.; in a small "weighing room" of same, ·13041 to ·13205; in the Myrtle st. Grammar School, ·13431 to ·13659; in the Tremont st. id., ·14335; the Richmond st. id., ·17781; in the Blossom st. id., ·19037; in the Appleton st. Primary School, ·11092; in the Cooper st. id., ·19927; in Music Hall, Tremont st., ·14045; in the Public Library waiting room, on three different days, each, ·13666, ·13747, ·19352.—*Second Ann. Rep. Mass. State Board of Health*, 1871.

3. *Report of the Board of Health of the City of Chicago for* 1867, 1868, *and* 1869, *and a Sanitary history of Chicago from* 1833 to 1870. 332 pp. 8vo. Chicago. 1871.—The officers of the Board, are Samuel Hoard, President; John H. Rauch, M.D., Sanitary Superintendent and Registrar of Vital Statistics; Ambrose Burnam, Health Officer; J. W. Russell, Secretary. The report is illustrated with diagrams and maps, and is an exceedingly important contribution to the subject. The diagrams show that the period of highest mortality at Chicago during the years 1867, 1868 and 1869, was between the 20th of July and 1st of September; and that the period of increase began late in June or very early 1st of July.

4. *Effect of the Eclipse on the Magnetic Needle;* by D. MULLER, (Gaz. offic. del Regno d'Italia).—On the 22d of December the magnetic needle followed its usual course till the commencement of the eclipse. It then retraced its steps until it reached its minimum declination at $1^h\ 58^m$, which was the instant of totality. From that moment the ascending motion toward the west began anew, until the needle had regained the exact position it had occupied when the eclipse began.—*Athen.*, Feb. 18.

5. *Establishment of Paul Mohr in Ohio for the sale of fossils and minerals.*—This establishment has been opened at Bantam, Clermont Co., Ohio. Mr. Mohr, of Vienna, is in communication with various European houses, and states that he can furnish specimens or collections at low rates.

6. *Corrosion of Lead pipes.*—A paper on this subject, by Wm. Ripley Nichols, is contained in the 2nd Ann. Rep. of the Mass. State Board of Health, 1871.

7. *Chemical Society.*—Prof. FRANKLAND has succeeded Prof. Williamson as President of the Chemical Society.

OBITUARY.

LARTET, the discoverer of human relics and remains in caves and Quaternary formations in France, the principal author of the *Reliquiæ Aquitanicæ*, and an active member of the French Institute, died in the department of Gers, during the investment of Paris. He was Professor of Paleontology at the Museum of Natural History, filling the place left vacant by the death of d'Archiac.

BECQUEREL, the physicist, died in Normandy during the siege of Paris, at the age of eighty.

GUILLAUME LEJEAN, Secretary of the Geographical Society of France and author of various Geographical papers, has recently died.

HAIDINGER, of Vienna, the veteran mineralogist, crystallographer and physicist, and the most active promoter of scientific progress in Austria, died in the latter part of the month of March.

Catalogue of Minerals with their Formulæ and Crystalline Systems; prepared for the use of the students of the School of Mines, of Columbia College; by THOMAS EGGLESTON, Prof. Min. and Met. 2nd ed., 42 pp. 8vo. New York, 1871.